Transport Canada
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Développement

TP 7051E

Research and Development in support of Aviation Regulations 1985–1990

Summary Report

Prepared for
Transportation
Development Centre
Transport Canada

by
Peat, Marwick and Partners
in collaboration with
Battelle Columbus Laboratories

DECEMBER 1985

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RESEARCH AND DEVELOPMENT

in support of

AVIATION REGULATIONS

1985-1990

SUMMARY REPORT

Prepared by

PEAT, MARWICK AND PARTNERS

in collaboration with

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December 1985

The contents of this report reflect the views of the contractors and not necessarily the official views or policies of the Transportation Development Centre.

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PROJECT TEAM

The project team consisted of:

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17. Abstract

The report presents the results of a study to develop a comprehensive research and development program for the Regulatory Directorate (DGAR) of the Aviation Group, Transport Canada. The planning horizon is five years.

Identification of DGAR program requirements was undertaken by means of a two-fold approach, based on the role of R&D in a regulatory organization and on the need to satisfy both longer term (3-5 years) and more immediate (1-2 years) needs of the program. An R&D planning framework was established and major R&D thrust areas were identified by means of a deductive analysis of safety goals. Individual R&D projects were developed on the basis of an extensive interview program with senior officials of DGAR branch organizations, and review of input received from the aviation community. Ranking of projects was undertaken by means of a scoring method, using pre-established decision criteria. Overall objective was to improve safety without imposing an undue burden on the aviation community.

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17. Résumé

Ce rapport présente les résultats de l'étude sur l'élaboration d'un programme détaillé de recherche et de développement pour le compte de la Direction générale de la réglementation du Groupe de l'aviation de Transports Canada. La planification porte sur cinq ans.

Une méthode à deux volets, basée sur le rôle que jouent la recherche et le développement dans un organisme de réglementation et sur la nécessité de satisfaire et les besoins à long terme (de 3 à 5 ans) et les besoins à court terme (de 1 à 2 ans) du programme, a permis de cerner les besoins en R&D. Nous avons établi un cadre de planification pour la recherche et le développement et identifié les divers domaines où la R&D s'imposait, par voie d'une analyse déductive des objectifs en matière de sécurité. Des projets distincts de R&D ont été élaborés d'après un programme d'entrevues avec les hauts fonctionnaires des divisions et l'étude des données fournies par le domaine de l'aviation. Le classement des projets s'est fait à partir d'une méthode de points, à l'aide de critères de décision préétablis. L'objectif global visait à améliorer la sécurité sans imposer de charges excessives au monde de l'aviation.

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SUMMARY REPORT

1. INTRODUCTION

The safety of the National Civil Air Transportation System (NCATS) is safeguarded by the Aviation Group, Transport Canada in a number of ways:

- Directly, by the provision of terminal, way and vehicle facilities operated by Airport, Navigation and Flight Service organizations;
- Indirectly, by means of various safety promotional and educational outreach Programs, and
- By the establishment, surveillance and enforcement of regulatory standards and codes of conduct with respect to design, production, operation and maintenance of aircraft and other aviation products and services.

Responsibility for regulatory and non-regulatory safety promotional programs is vested in the Regulatory Directorate (DGAR), including the Aviation Safety Programs Branch (DSP). Since the Dubin Commission of Enquiry on Aviation Safety it has become increasingly evident that research and development (R&D) has an important role to play in supporting and improving the effectiveness of both regulatory and non-regulatory programs designed to safeguard and enhance the level of safety prevailing throughout the NCATS. As a result, the then CATA Administrator in his 1984 Management Guidelines, directed DGAR to develop an applied research and development program for aviation safety within the overall Transport Canada R&D program.

2. STUDY OBJECTIVES

In the light of the above directive of the Administrator, the Transportation Development Centre mandated the present study:

"To develop a comprehensive research and development program for the Aviation Regulation Directorate."

Work is to address all aspects of the DGAR mandate with a five-year planning horizon, and is to include:

- The crew workload characteristics and man-machine interface;
- Passenger safety and the vehicle design features, safety equipment and emergency procedures;
- Search and rescue and the equipment requirements for improved survival and recovery;
- Airworthiness measures related to airframe life, crash survivability, fire suppression in design and fabrication of vehicle;
- Civil Aviation Security in detecting threats to air travellers' safety.

3. PROGRAM DEVELOPMENT APPROACH

Identification of DGAR R&D Program requirements was undertaken by means of a two-fold approach, based on the role of R&D in a regulatory organization, and on the need to satisfy both longer term (3-5 years) and more immediate (1-2 years) R&D needs.

Over the longer term, R&D requirements are a function of the mission goals of the organization, and on whatever policies may be adopted with respect to these goals. This calls for a deductive or "top down" method, based on a strategic review of the organization and its mandate, which

would derive R&D requirements from safety objectives or other statements of intent such as ROPS. It was necessary to devote considerable effort to this aspect of the study, due to the embryonic status of safety planning within the DGAR at this time.

For the more immediate term, R&D requirements are a function of means rather than ends, specifically of ongoing programs, and of the various operational and administrative activities of DGAR branch organizations. This calls for a more inductive or "bottom up" approach designed to establish a "wish list" of specific projects to be ranked according to pre-established criteria. This part of the work involved an extensive program of interviews with responsible officials within the DGAR, coupled with a review of input received from the aviation industry.

4. R&D PLANNING FRAMEWORK

Recent policy and administrative changes resulting from the recommendations of the Dubin Commission, have considerably enhanced the role of the Regulatory Directorate. At the same time, certain aspects of the mandate respecting safety and other matters, relationships with other Transport Canada organizations and external bodies such as the Canadian Aviation Safety Board (CASB), and organizational developments respecting the longer term status of the Aviation Safety Programs Branch (DSP), are yet to be established. In particular, there is no planning framework for safety to offer resource allocation guidance for specific domains (e.g., prevention versus protection, commercial versus private, etc.)

These conditions made it necessary to establish a preliminary framework for the ordering of the various safety programs and activities currently performed by DGAR branch organizations. As a first step, a goal framework was established in terms of the three major battle-lines that may be drawn with respect to "safety" as follows:

- Preventing accidents (and security threats);
- Protecting the aircraft occupant in the event of an accident (impact survival);
- Enhancing his chances of post-accident survival and recovery.

While the importance of accident prevention measures is acknowledged, it is in fact only the first line of defence. Indeed, experience over the years has shown that the very success that has been achieved in aviation crash prevention, has made it increasingly cost-effective to seek further improvements in "safety" through programs designed to protect the victims of accidents from the crash impact (second line of defense) or to ensure their subsequent survival and recovery (third line of defense). Unfortunately, however, reliable guidelines to resource allocation have yet to be developed.* As the principal safety watchdog of the NCATS, the DSP is heavily involved in the first two areas. However, with respect to post-accident survival, responsibility is relatively limited. While the Directorate is responsible for Search and Rescue standards for example, it has no direct program involvement with airport crash fire rescue (CFR) services or emergency medical services (although it can recommend corrective action in these and other areas).

5. MAJOR R&D THRUST AREAS

Research and development for a regulatory organization is used primarily to support the program needs of branch organizations. Typically, the output of this activity takes the form of guidelines, criteria or other information needed to supply the technical basis for policy or program changes involving new or revised standards, regulations or compliance procedures,

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*** Additional safety goals with respect to user classes (commercial, private, etc.) phase of flight (approach/landing, take-off, en route, ground, etc.), accident category (undershoot, engine failure, etc.) must await development of additional analytical capability within DSP.**

new advisory or educational material for the aviation community, or proposals for more effective surveillance or sanctions. While it is not an activity which fits easily into neat technological pidgeon-holes, the longer term R&D needs of DGAR branch organizations may be grouped in the form of R&D required in support of:

- Rule-making activity;
- NCATS monitoring and surveillance activity;
- Management systems and support activity.

For example, a requirement for improved certification standards or criteria for the crashworthiness of passenger seats might require information about the dynamic response capabilities of seat restraint systems and their occupants. Support for rule-making might be followed by study to determine, e.g., inspection requirements and (to push the example further) automation of office systems required to support branch activity as a whole. (This latter is a grey area which may or may not be included as R&D depending on administrative funding arrangements). Review of DGAR branch requirements revealed the following:

1. Airworthiness Branch

Airworthiness programs are concerned with the vehicle component of the NCATS, and include both airworthiness (i.e., accident prevention) and crashworthiness (i.e., occupant protection) type activity. While Canadian rule-making is based largely on standards adopted from the U.S. FARS system, a majority of R&D requirements is expected to arise out of certain aspects of the Canadian operational and manufacturing environment, in respect of which, U.S. airworthiness and crashworthiness regulations are deficient. Specific Canadian operating characteristics include:

- the extensive use made by commercial operators of small aircraft on skis and floats, to take advantage of natural landing surfaces in remote communities;

- low temperatures experienced for a significant part of each year, causing prolonged cold soak of aircraft prior to operation;

- remote operations of rotorcraft in both low temperature (arctic) and salt water environments;

- significant use of aircraft as platforms for airborne photographic and geophysical survey activities.

Specific characteristics of Canadian aircraft manufacturing include developments such as:

- aircraft with short take-off and landing characteristics (STOL);

- families of small gas turbine engines, both turboprop and turbojet;

- special purpose aircraft, both as original designs and as modified designs (e.g., firebombing aircraft designed to drop fire retardant liquids onto forest fires);

- digital navigational equipment and aircraft instruments;

- new helicopter manufacturing capability.

In addition, Canadian R&D in support of airworthiness and crashworthiness requirements can benefit significantly from joint project arrangements with the FAA and other regulatory organizations. In support of airworthiness, the following are considered the major candidate areas for cooperative ventures of this kind:

- primary structure composite materials;

- advanced control system technology;

- automated cockpits and systems management;

- prop-fan powerplant technology;

- next generation structural materials;
- STOL operations;
- rotor containment;
- foreign object ingestion.

In support of crashworthiness, the following possibilities were identified:

- Crash-resistant fuel systems;
- Aircraft seats and support structures;
- Restraint systems;
- "Fly-away" cabin materials;
- Passenger smoke masks and hoods.

In summary, R&D over the longer term will be required largely in support of ongoing rule-making activity. While additional requirements in support of operational and management functions of the branch are not excluded, they are not expected to contribute a large share of total program needs.

2. Licensing and Certification Branch

Licensing and Certification programs emphasize accident prevention by regulating the human component of the NCATS through mandatory personnel standards and operating procedures. However, in spite of a growing interest in human factors research, R&D to date has been limited to joint FAA/CATA evaluation of pilot judgement training.

Plans for the future include further development requirements in the field of pilot judgement training and certification and basic research to evaluate the effects of stress and pilot workload factors.

In summary, potential R&D requirements may be classified under the following major thrust areas:

- Research related to standards for the selection and training and proficiency testing of aviation personnel (pilots, navigators, instructors, controllers, AME's, etc.)
    - screening process (applications, reference checks, interviews, medical examination requirements, etc.);
    - education standards and procedures (skill requirements, examination requirements, flight training and testing, judgement training, etc.);
    - proficiency requirements (proficiency test standards and procedures, refresher training, specialty training, periodic medical checks, etc.).
- Research related to the certification of aviation safety programs and operating procedures (air carriers, airport and aeronautical facilities):
- Research related to the establishment of internal management systems and procedures.

3. Enforcement and Legislation Branch

Enforcement programs seek to prevent accidents by ensuring compliance with established standards and regulations, preferably by various "enforcement prevention" activities, but also by threat or actual use of sanctions where necessary. In keeping with the role of this organization, requirements for R&D focus more on monitoring and surveillance than on rule-making functions. Study will be directed to improving or evaluating the effectiveness of existing policies and programs (rather than on the development of guidelines for the establishment of new programs).

EXHIBIT 1

FINAL RANKING OF RESEARCH PROGRAM ELEMENTS

PROJECT DESCRIPTION	WEIGHTED DECISION CRITERION								TOTAL
	1	2	3	4	5	6	7	8	
Explosive Vapour Detector	1.80	1.48	0.60	0.60	1.40	0.92	0.63	0.43	7.86
X-Ray Screening System	1.80	1.48	0.60	0.60	1.40	0.81	0.63	0.43	7.75
ELT Carriage Policy	1.60	1.39	0.53	0.60	1.23	0.81	0.63	0.60	7.39
Passenger Baggage Matching	1.80	1.20	0.56	0.56	1.31	0.81	0.63	0.43	7.30
Safety Management Planning	1.80	0.63	0.68	0.68	1.49	0.92	0.72	0.34	7.26
Update Pilot Manuals	1.60	1.67	0.45	0.53	1.23	0.81	0.59	0.38	7.26
Air Taxi Training Materials	1.60	1.68	0.45	0.45	1.23	0.81	0.59	0.38	7.19
Passenger Safety Needs	1.80	1.39	0.56	0.56	1.23	0.69	0.54	0.38	7.15
SAFE Functional Classifications	1.80	0.83	0.64	0.64	1.23	0.86	0.68	0.43	7.11
Security Training	1.80	1.12	0.53	0.53	1.23	0.81	0.59	0.43	7.04
Methodology to Certify Judgement	1.60	1.68	0.45	0.30	1.23	0.81	0.59	0.38	7.04
Develop Aviation Training Materials	1.60	1.67	0.30	0.49	1.23	0.81	0.59	0.34	7.03
Passenger Breathing Equipment	1.60	1.30	0.49	0.49	1.31	0.81	0.50	0.51	7.01
Aircraft Overloading	1.60	1.02	0.56	0.56	1.31	0.81	0.63	0.51	7.00
[illegible]rcraft Inspection	1.60	1.12	0.45	0.49	1.31	0.81	0.63	0.51	6.92
[illegible]rnal Loads	1.60	1.30	0.45	0.45	1.23	0.81	0.63	0.43	6.92

PROJECT DESCRIPTION	WEIGHTED DECISION CRITERION								TOTAL
	1	2	3	4	5	6	7	8	
Performance on Substandard Runways	1.50	1.39	0.45	0.41	1.31	0.81	0.50	0.55	6.92
Bear Paws for Helicopters	1.60	1.30	0.45	0.45	1.23	0.81	0.63	0.43	6.90
Cockpit Resource Management	1.50	1.59	0.41	0.38	1.23	0.69	0.59	0.51	6.90
Information for SAFE	1.80	0.56	0.64	0.64	1.23	0.86	0.68	0.47	6.88
Low-level Operations	1.60	1.02	0.45	0.49	1.23	0.75	0.63	0.51	6.68
Bulk Liquids and Cyrogenics	1.60	1.02	0.45	0.49	1.14	0.81	0.63	0.47	6.61
Survival Needs	1.40	1.12	0.49	0.49	1.14	0.81	0.63	0.38	6.46
Hazardous Substances Effects	1.50	1.12	0.45	0.45	1.23	0.81	0.59	0.30	6.45
Skiplane Performance	1.50	0.93	0.45	0.45	1.23	0.81	0.59	0.43	6.39
Passenger Education Requirements	1.50	1.39	0.45	0.45	1.05	0.63	0.50	0.38	6.35
Pilot Behaviour Modification	1.50	1.39	0.45	0.41	0.96	0.58	0.50	0.47	6.26
CAIS System Implementation	1.40	0.93	0.45	0.45	1.23	0.81	0.36	0.60	6.23
Surveillance Evaluation	1.40	1.12	0.49	0.49	1.23	0.52	0.54	0.34	6.13
Basic Research Study	1.40	1.30	0.38	0.30	1.05	0.58	0.54	0.51	6.06
Sanctions Effectiveness	1.40	0.93	0.49	0.49	1.23	0.58	0.54	0.34	6.00
Repeat Offender Profile	1.30	0.93	0.49	0.49	0.88	0.58	0.54	0.34	5.55
Profile of Pilots Killed	1.20	0.93	0.45	0.45	0.88	0.58	0.54	0.34	5.37

4. Security Branch

Security research and development requirements are largely a function of the growing need for improved screening systems and devices. Resources required will depend on the nature and seriousness of the perceived threat. Much of this work will be undertaken, as before, in cooperation with U.S. and other security authorities.

5. Aviation Safety Programs Branch

The embryonic status of the DSP organization suggests that a large part of R&D requirements will be in the form of management systems support. A key component of DSP activity is analysis of system deficiencies through the System Analysis and Functional Evaluation (or "SAFE") System. R&D will be required to further refine and define this important monitor of NCATS system safety.

6. CURRENT R&D DEMAND

Current R&D demand was established as a result of an extensive program of interviews with key personnel in the various DGAR branches. Projects were developed in the form of brief project descriptions which were revised on the basis of comments received back from the branches (see Appendix A of the Main Report). Projects were then ranked according to a criteria scoring system (see Appendix B of the Main Report for details of this). Exhibit 1, opposite, lists the thirty-one projects developed for the program according to the final rank order.

7. R&D SUPPLY

Research and development requirements of DGAR branch organizations may be met and supplied:

- in-house;
- cooperatively with others;
- exclusively by others and made available free (as published/finished reports) or under contract.

Limited in-house resources suggest that the majority of R&D requirements will be performed by specialized institutions. Considerable emphasis has been and should continue to be placed on defining cooperative ventures with other organizations, principally the FAA. This is particularly important at a time when the FAA is developing an integrated research and development plan of its own, including R&D in the field of safety.

8. STRATEGIC PROGRAM DEVELOPMENT

Program development and implementation will depend on a number of Program elements such as project priorities, program scheduling requirements, the human and financial resources available to the Program and R&D organizational and management arrangements. In addition, program management should be sensitive to certain key issues.

In terms of the various projects identified by review of DGAR Branch requirements, the R&D Program may be summarized as follows:

Sponsoring Branch Organization	Number of Projects	Estimated Cost ($)
Airworthiness Branch	9	1,123,000
Aviation Security Branch	4	1,005,000
Licensing and Certification Branch	7	470,000
Aviation Safety Programs Branch	7	200,000
Enforcement and Legislation Branch	6	190,000
TOTAL DGAR	33	$2,988,000

Successful Program implementation will require attention to a number of concerns that were voiced during the course of work. These include:

- Concern over the level of funding that may (or may not) be made available;
- Concern over R&D Program management, specifically over potential loss of Branch control over Program and project priorities;
- Concern that increased "bureaucratization" could delay approval and funding of urgent requirements;
- Differences over the notion of "Research and Development" among Branch management;
- Differences over the notion of "safety", specifically with respect to safety objectives and priorities beyond the notion of "adequacy" and the shifting sands of public opinion and media attention.

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17. Résumé

Ce rapport présente les résultats de l'étude sur l'élaboration d'un programme détaillé de recherche et de développement pour le compte de la Direction générale de la réglementation du Groupe de l'aviation de Transports Canada. La planification porte sur cinq ans.

Une méthode à deux volets, basée sur le rôle que jouent la recherche et le développement dans un organisme de réglementation et sur la nécessité de satisfaire et les besoins à long terme (de 3 à 5 ans) et les besoins à court terme (de 1 à 2 ans) du programme, a permis de cerner les besoins en R&D. Nous avons établi un cadre de planification pour la recherche et le développement et identifié les divers domaines où la R&D s'imposait, par voie d'une analyse déductive des objectifs en matière de sécurité. Des projets distincts de R&D ont été élaborés d'après un programme d'entrevues avec les hauts fonctionnaires des divisions et l'étude des données fournies par le domaine de l'aviation. Le classement des projets s'est fait à partir d'une méthode de points, à l'aide de critères de décision préétablis. L'objectif global visait à améliorer la sécurité sans imposer de charges excessives au monde de l'aviation.

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I. INTRODUCTION

The present report documents the results of work undertaken by Peat Marwick in cooperation with Battelle Columbus Laboratories, to establish a framework for a comprehensive research and development program for the Regulatory Directorate (DGAR) of the Aviation Group, Transport Canada. The program identifies the R&D needs of the DGAR, provides a framework for priorizing these needs and identifies the resources (R&D Performers) available in Canada and abroad to undertake the work.

BACKGROUND AND RATIONALE FOR DGAR R&D PROGRAM

Research and Development in Transport Canada is required primarily to support the attainment of transportation objectives (including transportation safety objectives) in the areas of:

- policy development;
- regulation;
- government operations and services (e.g., airport operations, air traffic control services);
- economic/industrial development.

In support of these various roles in the air mode, the Secretary of the Aviation Group R&D Committee asked the Director Generals (formerly Assistant Administrators) for the Policy (DGAP), Airports, Navigation (DGAN), and Regulation (DGAR) Directorates, to prepare an overview of their ongoing and future R&D activities and plans*.

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* cf. DGAP memoranda of June 5, 1984 and August 13, 1984 to then Assistant Administrators.

In order to meet the needs of the R&D Committee, the Regulatory Directorate (DGAR) tasked the Director General of Research and Development (DGRD) through the Transportation Development Centre (TDC) to prepare terms of reference for the present study.

MANDATE AND OBJECTIVES OF STUDY

Aviation safety regulation is one of the Aviation Group's major responsibilities, the importance of which has been recently underlined by the Dubin Inquiry report. It has become increasingly evident that R&D has an important role to play in supporting and improving this activity. As a result, the Assistant Deputy Minister, Air (formerly the Administrator) in his 1984 Management Guidelines, identified the following requirement (Section 5.2.17):

> "Issue: The requirement for research and development to address aviation safety issues.
>
> Strategy: Develop an applied research and development program on aviation safety within the overall Transport Canada R&D Program.
>
> Direction: Under the general direction of the Aviation Safety Component of DGAR,* each group in DGAR is to develop proposals for research projects with the following being given priority:
>
> - proposals concerning human factors in aviation safety; such as stress and boredom;
> - proposals aimed at investigating professionalism as it pertains to commercial aircrew and passenger attendants;
> - proposals concerned with fires, passenger safety and survival, composite material safety, and ELT's.

*** Aviation Safety Programs Branch (DSP) is the Office of Primary Interest (OPI) charged with this work.**

> The concept of further refining existing agreements with the NRC, FAA and NASA as these relate to aviation safety engineering research is to be explored. In doing so, the potential for Canadian Funding of up to 10% of the TEC of joint projects, with 10% of the research done in Canada, is to be considered."

In the light of these directives, the project objective is given as follows:

> "To develop a comprehensive research and development program for the Regulatory Directorate."

Work is to address all aspects of DGAR's mandate with a five-year planning horizon and is to include the following areas:

- The crew workload characteristics and man-machine interface;
- Passenger safety and the vehicle design features, safety equipment and emergency procedures;
- Search and rescue and the equipment requirements for improved survival and recovery;
- Airworthiness measures related to airframe life, crash survivability, fire suppression in design and fabrication of vehicle;
- Civil aviation security in detecting threats to air travellers' safety.

For purposes of program development, "research and development" will be defined according to Section 3 of the DM Circular of March 29, 1984. (TP100). R&D can thus include a spectrum from "soft" planning and assessment studies to hard technical design and demonstration of new technology.

PROGRAM DEVELOPMENT APPROACH

The Research and Development needs of an organization such as the DGAR are necessarily a function of the role and mission objectives of the Directorate as a whole together with its interrelationships with other organizations. The situation is somewhat complex at the present time as a result of Dubin recommen-

dations, leading to wide-ranging legislative and procedural changes and to a radical restructing of the Aviation Group, including the establishment of the Aviation Safety Programs Branch (DSP) function. As a result of the DSP mandate:

> "To develop and implement aeronautical safety programs by addressing Canadian Aviation Safety Board Recommendations; analyzing system deficiencies; researching areas of aviation safety concern; disseminating aviation safety information to the aviation community contributory to safe and efficient operation of the Civil Air Transportation System,"*

the regulatory function of the DGAR has also been extended to other (largely non-regulatory) safety areas.

More importantly for study purposes, this restructuring process is far from complete. The Regulatory organization is still in a developmental phase. A management study is in progress but will not be acted upon for some time. Management systems and procedures are being developed by DSP but limited resources have left little time for any formal attention to the roles, objectives, policies and strategies required for meeting longer term safety goals. Functional relationships with external groups such as Aviation Medicine, (DAM), other Directorates (Navigation and Airports Authority Group) and the Aviation Community at large are steadily evolving, but the detailed jurisdictional responsibilities for aviation safety have yet to be defined.

Under these circumstances, the study team found it necessary to give considerably more attention to strategic issues than originally anticipated. In effect, a two-fold thrust to identifying R&D needs was undertaken.

1. Deductive approach to identifying longer term (2-5 years) R&D thrust areas from analysis and evaluation of safety mandate/objectives and ongoing organizational developments.

2. Inductive or "bottom up" interview program of relevant R&D user groups such as the regulatory branches of DGAR, non-regulatory groups within DSP, and other agencies, to determine the more immediate R&D project requirements.

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* CATA "Aviation Regulation Operational Plan Framework Submission"

The R&D program framework that emerges reflects a somewhat greater emphasis on current perceptions of R&D need. This is inevitable until greater attention can be given to the policy and strategic aspects of safety program planning than has been possible so far. The R&D program framework developed here must therefore be regarded only as a first step in an evolving pattern of needs as new safety policies and priorities emerge over the time frame of study.

Appendix D provides a listing of the names of individuals and organizations contacted.

STRUCTURE OF REPORT

The present report is composed of seven major sections. Following this introduction Aviation Group responsibilities with respect to aviation safety are outlined and the present organizational arrangements are briefly described. Section three introduces a general discussion of safety and leads on to develop a planning framework for DGAR safety objectives and programs, including R&D. Section four outlines the major R&D thrust areas for each of the main DGAR branch organizations, based on the principal functions performed by them. User demand for R&D in the form of specific projects is introduced in Section five and described in greater detail in Appendix A. This is followed by a discussion of the manner in which this demand may be met and work performed. A final section discusses the strategic aspects of program development for the future.

In addition to Appendix A, the report includes an outline of the method used to provide a preliminary ranking of projects (Appendix B), a discussion paper on aviation safety objectives (Appendix C) and a list of people interviewed during the course of the study (Appendix D). Finally, a selected bibliography has been added (Appendix E) listing the major documents and reports consulted during this project.

II. AVIATION SAFETY IN THE AVIATION GROUP

The Aviation Group Safety mandate derives from this Group's Role Strategic Objective 4:

> **"To ensure that an adequate level of safety is provided for the national civil air transportation system."**

However, as recognized in the 1984 Management Guidelines (Section 3.1), the very notion of safety and its "adequacy" is an elusive concept, and "adequacy must continue to be tested for in a constantly changing environment".*

In a broad sense, the Aviation Group's safety responsibilities with respect to the integrated National Civil Air Transportation System (NCATS) of Terminal, Way and Vehicle, are discharged in a number of ways:

- Directly, by the provision of terminal, way and vehicle facilities and the resources required to operate them (including the necessary safety management policies, plans, and programs). Jurisdictionally, this responsibility is currently shared between Airports Group (terminal), DGAN (way) and DGAF (departmental aircraft operations).

- Indirectly, by means of various safety promotional and educational outreach Programs, and

- By the establishment, surveillance and enforcement of regulatory standards and codes of conduct designed (primarily though not exclusively) to ensure an "adequate" safe operation of the commercial and private (G.A.) vehicle component of the system.

Responsibility for regulatory and also for non-regulatory safety promotional programs is vested in the Regulatory Directorate (DGAR) including the Aviation Safety Programs Branch (DSP). The above jurisdictional division of responsibilities has two important consequences for DSP. In the first place, as safety monitor and coordinator, DSP does not manage or have direct operation-

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*** CATA. "1984 Management Guidelines: Issues, Strategies, Directions". Section 3.1: National Civil Air Transportation System Safety.**

al control over any part of the NCATS (whether of vehicles, terminals or way). As a result, the system safety management approach to safety enhancement, characteristic of operating departments such as DGAN (who recently attempted to introduce a "National Air Transportation Safety Plan" along these lines) must be replaced by a more eclectic safety philosophy, based on voluntary, and if necessary mandatory, compliance with aviation standards and operating rules.* DSP characteristically responds and recommends corrective responses to "safety deficiencies" or "system deficiencies" identified as a result of accident investigation by the Canadian Aviation Safety Board (CASB), or through analysis of information derived internally by the Aviation Group organization.

In the second place, both in its non-regulatory promotional outreach programs and in its role as safety clearinghouse for DGAR regulatory activity, the focus of attention and scope of DSP initiatives is mainly directed to the safe design, operation and maintenance of the vehicle component of the NCATS. While DSP analysis may reveal a safety deficiency in airport crash fire rescue (CFR) services for example, and may recommend corrective action, responsibility for airport safety is vested in the Airports Authority Group. This has important implications for the development of a safety R&D program since it effectively excludes airport safety (though not security) R&D from the program. At a more operational level, the following observations are in order.

PRESENT ORGANIZATIONAL STATUS

In accord with the Aviation Group/CASB Transfer Agreement, the Aviation Safety Programs Branch (DSP) of DGAR was established during 1984 with a complement of twenty-two person years (PY's) of whom thirteen were at headquarters plus nine regional safety officers in six regions across Canada. Headquarters staff were divided almost equally with seven person years in the Safety Research and Analysis Group (SPA) and six person years in Safety Promotions (SPP).

*** Emphasis is placed on self-regulation and voluntary compliance with safe operating practices.**

The original DMSP study* recommended a two-phase expansion to a total of sixty-one person years of whom forty person years would be at headquarters. A small R&D group was proposed. These numbers formed the basis for subsequent Treasury Board submissions, the most recent of which proposed a total of four R&D specialists of a total of nineteen person years within SPA.

While the subsequent A-Base Review** proposed no expansion of SPA beyond an additional passenger safety specialist and a single position to initiate and coordinate R&D, it did recognize the need for further study within the next two years. Clearly, the level of resources available to initiate and meet R&D objectives, will have major implications for the scope of an eventual R&D program in the years ahead.

MANAGEMENT DIRECTIONS AND MANDATE

With limited resources the DSP organization has necessarily tended to focus on the short-term demands of the moment rather than on strategic planning issues. However, a DMSP management study is currently investigating management and organizational development issues on behalf of DGAR. Unfortunately, the study has not yet focussed on the DSP organization per se. However, the A-Base Review did draw attention to a concern "that the management levels to which regional divisions and the headquarters branch report are too low" and that "It may be desirable to reassess, in the future, the reporting structure for the aviation safety programs function".**

The study team do not wish to prejudge or to recommend any course of management or organizational change in reporting relationships. However, any move to establish DSP as the focal point of aviation safety along the lines of the

---

* Management Systems Branch. CASB/CATA Interface Respecting Aviation Safety Analysis and Promotion. Project 282-985 (Report TP4259), 1982.

** Final Report. A-Base Review: Volume II Regulatory November 1984. TP 5876 Sections 2.10.11 and 2.10.34 (3)

the Director of Flight Safety for DND (who reports directly to the Vice-Chief of the Defense Staff) or the Director of the Office of Aviation Safety of the FAA (who reports directly to the Administrator), would have important implications for the DGAR R&D Program.

DSP SAFETY POLICIES AND PROCEDURES

DSP safety activities are conducted by two groups, Aviation Safety Promotion (SPP) and Aviation Safety Research and Analysis (SPA). The SPP Group is responsible for managing the non-regulatory safety programs of DGAR. The most important group for our purposes is the SPA Group of seven professionals at HQ who are currently engaged in developing the necessary policies and procedures involved in the following areas of activity:

- Management of the Aviation Safety Transmittal and Response Action System (ASTRA). This involves analysis, evaluation and transmission to the relevant OPI's, of CASB safety recommendations;
- The System Analysis and Functional Evaluation (SAFE) Program designed to identify safety problem areas, including regulatory violations. This program is dependent on information obtained from CASB (including the proposed Aviation Occurrence Reporting System), Aviation Group (such as the Civil Aeronautics Daily Occurrence Reporting System or CADORS, Fact-finding Board Reports, etc.) and external sources (such as SAR Reports, Coroners' Inquest Reports, etc.);
- Planning and establishment of cost effective safety remedial actions and programs. This involves evaluation to determine the impact of alternative safety strategies including whatever R&D support might be needed;
- Management, coordination and sponsorship of all R&D in support of all Aviation Group safety actions and programs.

Some of these programs and procedures are already in place (e.g., the ASTRA and SAFE program frameworks) while others (such as R&D coordination) are yet to be established. A major problem area at the present time is the absence of a formal policy framework for aviation safety. In the first place, there is no

working definition of "safety" to serve as a guide to the identification of safety problem areas, and no framework with which to classify safety problems and frame solutions.* In addition, there are no criteria as yet to allocate resources to specific classes of corrective action. An objective to prevent accidents for example, has different program and resource allocation implications than one of saving lives (which may emphasize protecting/evacuating accident victims). The following chapter addresses some of those considerations in greater detail.

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* The framework provided by the SAFE Analysis Manual is a good start in this direction but is relevant to accident prevention rather than to passenger protection or emergency response aspects of "safety". See also Appendix C for a discussion of safety objectives related to the now-defunct National Air Transportation Safety Plan.

III. SAFETY R&D PLANNING

Research and development is only one of a number of initiatives available to meet the overall safety requirements or objectives of the Regulatory Directorate. R&D is thus a function of safety goals and of the means used to meet these goals in the form of safety initiatives and programs. The present chapter seeks to establish a framework to structure R&D needs.

1. THE MEANING OF SAFETY

The meaning given to the term "safety" is important since it defines the programs to be developed and the results (objectives) to be achieved. Unfortunately there is no universally accepted or acceptable definition. However, the notion of aviation safety is generally regarded in one of two ways, as a condition (end) to be achieved, or as an activity (means) to be undertaken. An example of a condition definition of safety is afforded by the U.S. D.O.D. MIL-STD-882A.

> "3.5 Safety: Freedom from those conditions that can cause death, injury, occupational illness, or damage to or loss of equipment or property."*

An example of an activity definition of safety would be the following:

> "Safety is a function of anticipating undesirable consequences of behaviour and the capability to alter those consequences".**

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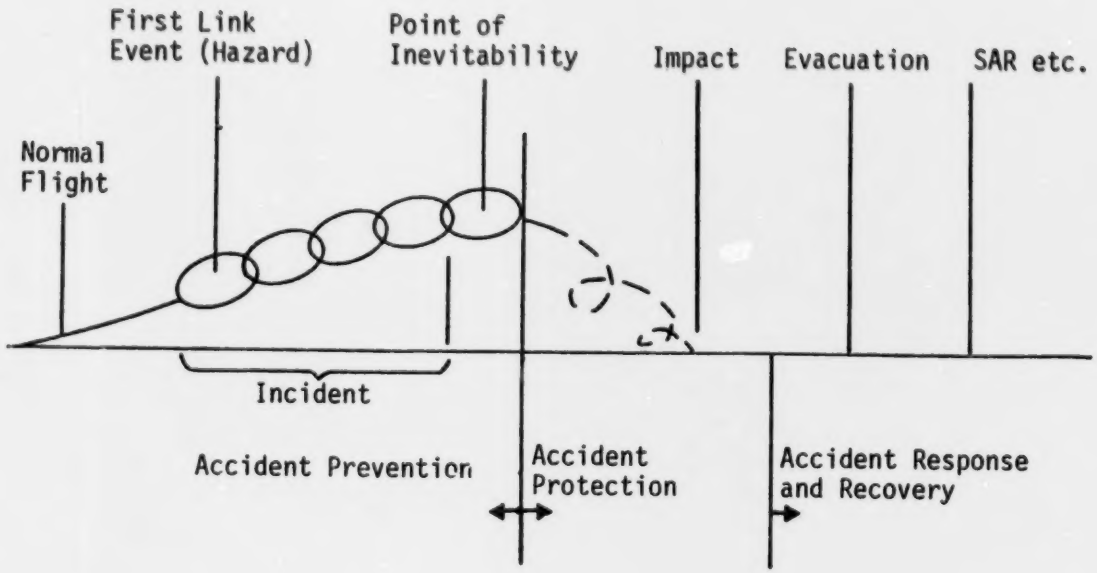
* U.S. Department of Defense. Military Standard on System Safety Program Requirements (MIL-STD-882A), Washington, June 28, 1977.

** Intendes Group Ltd. "Pilot Research Study on Transportation Safety" Transportation Development Agency, March 1972.

EXHIBIT 1

THE SCOPE OF AVIATION SAFETY



Source: Adapted from ICAO Accident Prevention Manual.

2. THE SCOPE OF AVIATION SAFETY

In an aviation organization, or indeed in any organization, the scope as well as the notion of "safety" will be a function of the mission objectives or mandate of that organization. In the military for example, where safety is a means to "mission accomplishment" (particularly in wartime), safety programs are required "to prevent accidental losses of aviation resources"*. The emphasis is largely on accident prevention in the interests of operational effectiveness. In civil aviation on the other hand, where safety is a primary goal, safety programs are required mainly to save lives and reduce bodily harm. Material losses are secondary. This tends to broaden the scope of safety from notions defined by condition standards of prevention (e.g., "zero risk of accidents") to statements of intent related to three primary safety areas: (cf. Exhibit 1, opposite).

- Preventing incidents and accidents (accident prevention);
- Protecting passengers and crew in the event of accidents (impact survival);
- Providing emergency response services for the location and survival needs of accident victims. (Post-accident survival).

Accident prevention remains an important safety ingredient which is defined by the International Civil Aviation Organization (ICAO) as follows:

> "The search for, detection and assessment of hazards and the development of appropriate methods and recommendations and the taking of actions to minimize or eliminate aircraft accidents and incidents."**

---

* National Defense "Flight Safety for the Canadian Forces". Manual A-GA-135-001, 1977

** ICAO "Accident Prevention Manual"

However, for an organization such as the Regulatory Directorate such activity is only the "front end" of aviation safety. Thus, while the above definition offers an accurate description of DSP accident prevention based on analysis of system deficiencies, increasing attention is being given to the passenger protection aspects of aircraft occupant safety, including in-flight protection, crash and post-crash fire protection, evacuation and crash survivability. This is in step with trends elsewhere. In the United States, "giving passengers the greatest possible chance of surviving in an impact-survivable accident ... is our number one priority".*

In addition, as OPI for Transport Canada responsibilities for search and rescue (though not for airport crash fire rescue and other emergency services), DSP must also devote attention to the third major component of aviation safety, in terms of the standards required for the provision of such facilities. (i.e., ELT's, Sparsely Settled Area Order etc.)

REGULATORY DIRECTORATE SAFETY GOAL FRAMEWORK

While the safety philosophy and objectives of the Regulatory Directorate have not been developed in any formal sense, a critical review of the activities of the Directorate and in particular of the Safety Programs Branch, (DSP) suggest that the organization is working to achieve major objectives in the following areas:

1. Accident Prevention

Accident prevention is "primary safety" in the sense that it remains the first line of defense in the protection of life and limb in Canadian aviation. The following would appear to be major goals in this area:**

---

* FAA Administrator Donald D. Engen at the Flight Safety Foundation Cabin Safety Conference and Workshop, Arlington, Va. December 11-14, 1984.

** As suggested above these are expressed as statements of intent rather than as quantitative goals. An example of quantitative goals may be found in Appendix C.

- Reduction of accidents and incidents (per unit of exposure) in
  - Commercial Aviation (Classes 1-8 by weight group as necessary);
  - General Aviation (Private);
  - Rotorcraft (RW Groups A-F as necessary).
- Reduction of aviation hazards with respect to:
  - vehicle (OPI is Regulatory Directorate);
  - terminal (OPI is the Airports Authority Group);
  - way (OPI is DGAN).
- Elimination of "catastrophic" accident conditions;
- Provision of internationally acceptable levels of aviation security.

Reduction of accidents/incidents and elimination of catastrophic events is currently undertaken largely through implementation of CASB recommendations, enforcement of regulatory standards and through the promotional (non-regulatory) activities of SPP. Hazard reduction is provided through corrective responses to system deficiencies. Aviation security is enforced through DAX, KSP, FSC, RCMP, etc.

Current program priorities as detailed in the 1984 and 1985 Management Guidelines and in the 1986/87 Planning Overview, emphasize commercial and business (Class 5) aviation, passenger safety, rotorcraft airworthiness and aviation security among other things.* However, development of additional analytical capability within DSP should eventually make it possible to focus attention on more specific problem areas. For example, in addition to the above user class categories, attention may be focussed on phase of flight (e.g., approach/landing, takeoff, en-route, ground, etc.), type of

---

*** Private aircraft alone account for about one-half of all accidents and 40% of fatalities in the Central Region cf. "Study of Aircraft Accidents in the Central Region" Report, August 1984.**

accident (e.g., undershoot, engine failure, etc.), cause (the U.S. NTSB Manual of Code Classifications contains fifteen major accident cause/factor categories with seventy additional subdivisions) and numbers of fatalities/injuries.

2. Accident Protection

Accident protection may be regarded as "secondary safety" in the event that an accident occurs. The objectives in this area would appear to be:

- Reduction of "in-flight" risks to aircraft occupants through in-flight fires, turbulence, decompression or other causes;
- Reduction of impact risks to aircraft occupants as a result of the "second collision" and its immediate aftermath (smoke, fire, evacuation procedures, etc.);
- Minimization of environmental damage and dislocation (e.g., hazardous materials).

The reduction of in-flight and impact risks to passengers is currently achieved largely by regulation (e.g., crashworthiness standards, passenger safety programs of LCOP) and implementation of CASB recommendations, although consideration is also being given to passenger education.

3. Accident Survival and Recovery

Post-accident recovery and survivability objectives are mainly directed to the general aviation and speciality segments of Canadian Air Transport (e.g., rotorcraft, northern commercial operations, etc.). They may be regarded as the third line of protection in the event that passengers or crew members survive the immediate effects of an accident. The following would appear to be among the more important concerns in this area:

- Enhancement of search and rescue (SAR) response capabilities:
  - land (OPI is DND);

. water (OPI is Coast Guard).

- Enhancement of crash rescue and fire fighting response times/ capabilities (OPI is the Airports Authority Group);
- Enhancement of emergency medical service (EMS) response capabilities (OPI is Health and Welfare), disaster preparedness, etc.

Safety enhancement in the post-accident recovery phase is largely the responsibility of other organizations. The prime responsibility of the Regulatory Directorate is in the area of rule-making, particularly as regards emergency locator transmitter (ELT) and survival equipment requirements.

IV. MAJOR R&D THRUST AREAS

Research and development for a regulatory organization such as the Regulatory Directorate is used primarily to support the program needs of individual branch organizations. Typically, the output of this activity takes the form of guidelines, criteria or other information needed to supply the technical basis for policy or program changes involving new or revised standards, regulations or compliance procedures, new advisory or educational material for the aviation community, or proposals for more effective surveillance or sanctions. While it is not an activity which fits easily into neat technological pidgeonholes, the longer term R&D needs of branch organizations may be grouped in the form of R&D required in support of:

- Rule-making activity;
- NCATS monitoring and surveillance activity;
- Management systems support activity.

For example, a requirement for improved certification standards or criteria for the crashworthiness of passenger seats might require information about the dynamic response capabilities of seat/restraint systems and their occupants. Support for rule-making might be followed by study to determine, e.g., inspection requirements and (to push the example to the end) automation of office systems required to support branch activity as a whole. (This latter is a grey area which may or may not be included as R&D depending on administrative funding arrangements.) In addition, hardware-oriented R&D may be required, particularly in areas related to airworthiness and aviation security. In the words of one of the manufacturers;

> **"New technologies and airworthiness cannot be considered independently. These two subjects are inseparable in that regulation has a profound effect on how new concepts and techniques are developed for the civil field, whilst new design and operating concepts strongly influence the formulation of requirements. Therefore, it is important that the regulatory authority is actively involved in the current thrust of R&D."**

The fact that the demand for safety-related R&D is derived more directly from the counter-measure than from the original safety deficiency makes it difficult to derive actual R&D projects from safety objectives. Projects represent the more immediate needs of the Regulatory organization and must be developed "from the bottom". However, as the longer term context for safety programs as a whole, the goal framework outlined in the previous chapter may be used to derive the major R&D program thrust areas. While these thrust areas are not synonymous with actual projects, they do define the generic areas of R&D that are likely to be needed over the longer term.* The emphasis is towards applied research leading to information related to design, production, maintenance and operating standards and procedures that meet the needs of the regulatory branch organizations and the DSP. In each case the objective is to maintain or improve the level of aviation safety without imposing an undue burden on the aviation community.

In this context, the following major R&D thrust areas may be identified.

A. ACCIDENT PREVENTION

A large part of Regulatory efforts is devoted to programs designed to minimize the risk of accidents occurring. This is accomplished through airworthiness programs related to the design, construction, maintenance and operation of the vehicle itself, through licensing and certification programs related to aviation personnel, facilities and flight operations, and through enforcement programs designed to ensure compliance with the mandatory standards and operating rules prescribed by legislation. In addition, security programs seek to prevent unlawful interference with the safe operation of the various components of the

---

* Program thrust areas are also not synonymous with the "R&D Program" which will depend on relevance and availability of work performed elsewhere, and the potential for joint project agreements with other organizations.

system. Finally, aviation safety programs are now being established which monitor the safety of the NCATS to provide advance warning of system deficiencies and to recommend appropriate corrective action. In each of these major regulatory and non-regulatory areas, research and development may be required either in support of ongoing programs or to assist in the design of new programs needed as a result of existing system deficiencies or of prospective advances in new technology and operating procedures.

Airworthiness Programs ensure that an aircraft is of proper design, construction and performance for safe operation, and that each aircraft is produced and maintained to minimum standards. This involves two types of program, rule-making and certification. Rule-making programs consist in establishing the technical standards and regulations to be met by manufacturers and airlines in the course of designing, producing, operating and maintaining the aircraft. These programs are currently being reviewed and consolidated in the form of a new Canadian Airworthiness Manual. Certification is the auditing function to ensure that the design, production, operation and maintenance of aircraft and aeronautical products are performed in accordance with the relevant standards and regulations.

The bulk of airworthiness R&D requirements are expected to be needed in support of rule-making. While in Canada, rule-making is based largely on FAA standards embodied in the Federal Airworthiness Regulations (Design FARS) and the Federal Operational Regulations (Operational FARS), R&D is needed to assist in establishing certain Additional Airworthiness Requirements (AAR's) arising out of aspects of the Canadian operational and manufacturing environment, in respect of which the U.S. FARS are deficient. Specific Canadian operating characteristics include:

- the extensive use made by commercial operators of small aircraft on skis and floats, to take advantage of natural landing surfaces in remote communities;
- low temperatures experienced for a significant part of each year, causing prolonged cold soak of aircraft prior to operation;

- remote operations of rotorcraft in both low temperature (arctic) and salt water environments;
- significant use of aircraft as platforms for airborne photographic and geophysical survey activities.

Specific characteristics of Canadian aircraft manufacturing include developments such as:

- aircraft with short take-off and landing characteristics (STOL);
- families of small gas turbine engines, both turboprop and turbojet;
- special purpose aircraft, both as original designs and as modified designs (e.g., firebombing aircraft designed to drop fire retardant liquids onto forest fires);
- digital navigational equipment and aircraft instruments;
- new helicopter manufacturing capability.

In addition, Canadian R&D in support of airworthiness (and also crashworthiness) requirements can benefit significantly from joint project arrangements with the FAA and other regulatory organizations. In support of airworthiness, the following are considered the major candidate areas for cooperative ventures of this kind:

- primary structure composite materials;
- advanced control system technology;
- automated cockpits and systems management;
- prop-fan powerplant technology;
- next generation structural materials;
- STOL operations;
- rotor containment;
- foreign object ingestion.

Additional R&D required in support of airworthiness certification policies and procedures is expected to be geared largely to the introduction of technologies related to development initiatives in the field of commuter and STOL aircraft, balloons (Barnes, Fantasy 8), airships (Van dusen-Magnus), gliders (Canadian Aircraft Products), new rotorcraft production (Bell, MBB105LS), the National Simulator Approval Program, voluntary certification of light aircraft and procedures related to supplemental type approvals and Technical Service Orders (TSO's). (Recent studies of Aircraft Maintenance Engineer training and licensing fall into this category).

Finally, some R&D might be required from time-to-time in connection with the need for internal management systems (studies on the establishment of the SDR and CAIS reporting systems are examples of this type of R&D). For example, a pilot project involving office automation is currently being implemented.

In summary, review of airworthiness program requirements over the next five years revealed the following major thrust areas for this type of R&D.

- R&D related to information required to support changes in specifically Canadian requirements related to the airworthiness code;
- R&D related to airworthiness operational programs and program requirements, including type approval, airworthiness surveillance and continuing airworthiness functions;
- R&D related to the internal management information system and procedural requirements of DAB.

Licensing and certification programs emphasize accident prevention by regulating the human component of the NCATS through mandatory personnel standards and operational procedures. This also involves both rule- making (personnel licensing standards) and accreditation (licensing/ certification) functions. Thus, in contrast to airworthiness (where the emphasis is on the machine, specifically the vehicle), the R&D required in support of these programs is primarily concerned with the factors contributing to human errors of judgement, with pilot decision-making and with the safety-efficient integration of the human operator and the rapidly evolving machine environment. To the extent

that this work is aeromedical and ergonomic in nature, it will have to be co-ordinated with the Department of Health and Welfare through the National Advisory Committee on Research and Development (the NACARD Committee).

In spite of a growing interest in human factors research, Canadian R&D efforts in support of regulatory programs has been minimal. A joint FAA/Aviation Group evaluation of pilot judgement training was recently completed and further work to evaluate the effects of stress and other pilot workload factors is being planned.

The longer term requirements for human factors R&D in support of licensing and certification programs will be related to ongoing program needs. The rule-making needs of licensing standards are related to technological developments in the industry and the development of the "Civil Aeronautics Code" relating to personnel licensing resulting from the Aeronautics Act Task Force. Changes in current standards for example, will have to be made as a result of advances in avionics such as changing cockpit displays from a number of individual instruments to CRT and head-up displays, and the use of on-board computers affecting flight control systems and aircraft maintenance. Information related to this new man-machine interface will be required to assist in identifying the nature of the changes that will be required.

These new developments in technology will also make it necessary to make continuous adjustments to the various accreditation and inspection programs for licensing pilots (seven types of license), flight navigators, maintenance engineers and air traffic controllers, as also the airports themselves. Following Dubin Report recommendations, the examination format for pilot examinations is being revised, new mandatory topics such as weather are being introduced, low-time pilot education requirements are being enhanced and new training manuals will be required such as the Instrument Check Pilot Course and the Multi-engine Training Manual, both to be developed by 1988/89. Licensing and registration requirements related to the growing fleet of ultra-light aeroplanes must also be addressed. (Currently under study.)

New technology and the development of new aircraft and aircraft types (e.g., "lighter-than-air" balloon transport of raw materials) also makes it necessary to continuously monitor and update the rule-making and accreditation programs related to the certification of commercial aircraft operations, including compliance with passenger safety and dangerous goods standards and requirements.

Internal management requirements may also require some R&D over the time frame of the program. For example, the personnel licensing computer system must be made compatible with the newly developed Civil Aeromedical Screening System (CASS) by 1988/89.

While significant changes in these programs will be introduced over the next five years, the information support required from R&D is expected to be less than that required in the field of airworthiness. In summary, the potential R&D requirements may be classified under the following major thrust areas:

- Research related to standards for selection and training and proficiency testing of aviation personnel (pilots, navigators, instructors, controllers, AME's, etc.)
    - screening process (applications, reference checks, interviews, medical examination requirements, etc.);
    - education standards and procedures (skill requirements, examination requirements, flight training and testing, judgement training, etc.);
    - proficiency requirements (proficiency test standards and procedures, refresher training, specialty training, periodic medical checks, etc.).
- Research related to the certification of aviation safety programs and operating procedures (air carriers, airport and aeronautical facilities):
    - air operations certification standards and procedures;
    - air carrier inspection standards and procedures;
    - flight simulator evaluation;

- flight engineer training and checking;
- dangerous goods training and inspections;
- operations evaluation (base inspection, functional reviews);
- regional audits.

- Research related to the establishment of internal management systems and procedures.

Enforcement Programs seek to prevent the estimated 28%* of aircraft accidents considered to be "violation-induced" or related to non-compliance with established regulatory standards and procedures. Emphasis is given to "enforcement prevention" programs to promote voluntary compliance through lectures, seminars, counselling, publicity, and a visible "presence" in the aviation community. However, this activity must be supplemented by detection and investigation of complaints and alleged violations, and administrative (warnings, license suspension, etc.) and if necessary judicial enforcement procedures. In accordance with Dubin Commission recommendations (which elevated this function to Branch status) enforcement officers specialising in air carrier, general aviation and aircraft maintenance, are now being attached to regional offices. Attention is currently focussed in the area of airworthiness standards following growing evidence of non-compliance with airworthiness standards and regulations, particularly in northern areas. (Proposed economic deregulation of the industry could further exacerbate this problem.)

In keeping with the role of this organization, requirements for R&D focus more on monitoring and surveillance then on rule-making functions. The record in Canada suggests a modest enforcement-related R&D effort is required to improve or evaluate the effectiveness of existing programs rather than to provide planning information or criteria for the establishment of new programs.

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* Source: Enforcement and Legislation Branch. "Violation Accident Study Project" (Draft Report).

A major problem at the present time is lack of information regarding the effectiveness of surveillance activity. While it is clear that the vast majority of violations go unreported, it is not clear what this number might be. Efforts towards improving the success rate on prosecutions might also be enhanced by research in certain cases. Thus a method of estimating the altitude of low-flying aircraft would assist in securing convictions of those accused of violating the relevant regulations in this regard.

Most of the proposals reviewed for purposes of this study emphasize human factors and other forms of "soft" research activity. For example, needs have been identified for information on the psychological profiles of repeat offenders, on the violation histories of pilots killed in accidents and on the effectiveness of the various sanctions for enhancing compliance. In addition, administrative requirements could give rise to the need for research similar to that recently undertaken to computerize the legislative support function process and procedures.

Security Programs seek to prevent unlawful interference with the safe operation of the NCATS. While the protection of passengers, airports, aircraft and aeronautical facilities in the event of a sabotage occurrence is also an important consideration, this is largely in the hands of the RCMP and the airlines. The regulatory responsibility, based on the concept of "clean passengers, clean baggage, clean cargo, clean aircraft", includes the development of security measures regulations and security inspection standards based on national and international threat assessments provided by the RCMP, monitoring of airline security programs, and the provision of the appropriate passenger and baggage screening devices. (Screening operations are conducted by the airlines).

Research and development requirements are determined primarily by the growing need for improved electronic and other forms of screening. The National Research Council conducted considerable research during the 1970's under the auspices of the Committee on Aviation Security, and more recently, cooperative research with the FAA has been undertaken within the terms of the

McCleisch/Helms agreement (Addendum 4). Canada has taken a lead role in the area of Vapour Detectors for explosives and other substances (drugs, etc.). Explosive detectors are currently in place at Montreal, Toronto and Vancouver. A "Continuous Vapour Detector" for passenger search is currently under development. An objective is to automate the passenger screening function. Additional work is required to provide passenger profile information to assist the screening process at small airports.

Aviation safety programs, as the safety "conscience" of the Aviation Group, are watchdog programs primarily designed to prevent accidents by identifying system deficiencies in the NCATS (safety problem areas), determining appropriate corrective actions and implementing these in the form of recommendations to the relevant OPI on behalf of the Minister. These corrective actions could be regulatory or non-regulatory, depending on the nature of the safety problem and the cost/effectiveness of the available alternatives. Research and development requirements in support of these safety program initiatives will also be determined primarily on the basis of the nature of the safety deficiency and the cost/safety/effectiveness of available solutions.

It is difficult, if not impossible at this time, to determine the longer term R&D potential in support of safety programs, due to the embryonic status of a key program component, the System Analysis and Functional Evaluation (SAFE) Program for identifying system deficiencies. This program became operational in June 1985 but no trend analysis may be expected for some time. While additional R&D might be forthcoming out of the Aviation Safety Transmittal and Response Action (ASTRA) Program, this will depend on CASB recommendations based on the results of accident investigations. Since the CASB organization is also in the early stages of establishing the necessary systems (such as the Aviation Occurrence Reporting System) and procedures to conduct meaningful analysis of accident causes and trends, little information is currently available or may be developed on the type of R&D that might be needed from this source.

The embryonic state of the DSP and CASB organizations and management systems (both organizations are little more than a year old) suggests that the major source of R&D support of aviation safety programs will be in the form of management systems support. Following discussion with DSP program officers, the following R&D requirements were identified:

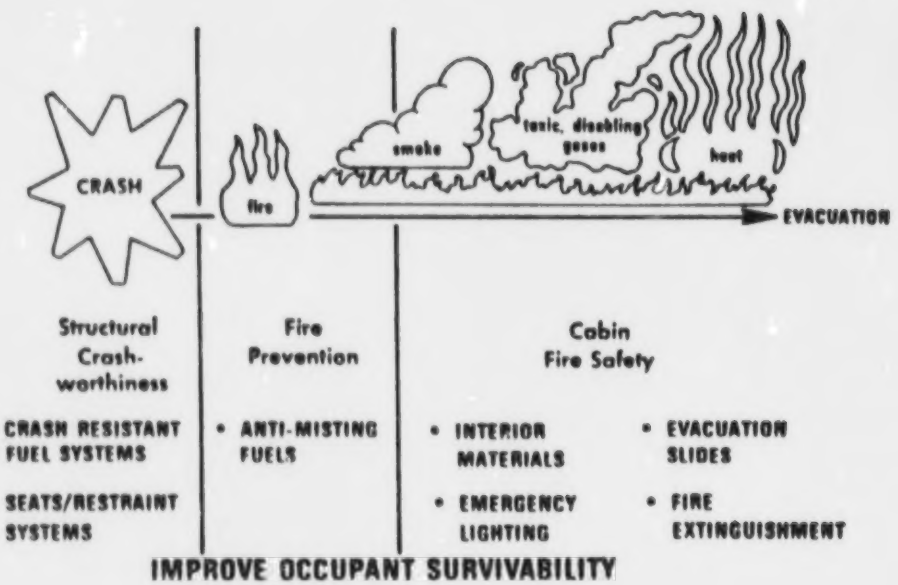
- Safety Management Planning to develop a comprehensive goal framework for Branch Organizations, including DSP ROPS, management structures/reporting relationships and safety program guidance;
- Research studies in support of development of SAFE Program, specifically
    - information needs and sources;
    - evaluation of the adequacy of functional classifications, particularly in the area of personnel.
- Study to define Passenger Safety R&D requirements generated by DMSP study;
- Attitudinal surveys to determine education requirements for passenger education program;
- Behavioral studies leading to formulation of safety awareness campaigns designed to modify attitudes to (unnecessary) risk-taking among pilot groups.

B. ACCIDENT PROTECTION

Paradoxically, every success that has been achieved over the years in aviation crash prevention has made it increasingly cost-effective to seek further improvements in "safety" through programs designed to protect the occupants of the aircraft in the event that an accident occurs. This trend began in the United States with the establishment of crash survivability criteria by the Aviation Crash Injury Research Project (AVCIR) in the early 1950's. These criteria emphasize the importance of maintaining the "living-space" within the aircraft, of ensuring that the aircraft occupant is properly secured within this living space, and that the crash loads are applied to the occupant in a manner

EXHIBIT 2

POST-CRASH SURVIVAL



Source: Federal Aviation Administration

which does not cause life-threatening injury. These criteria and others have led to the development of a variety of programs designed to improve the survivability of the aircraft occupant, including structural crashworthiness programs (such a crash-resistant fuel systems and the development of seat/restraint systems), fire prevention programs for in-flight and post-crash fires (e.g., development of anti-misting fuels) and cabin safety programs (such as the development of new interior materials, emergency lighting, and passenger evacuation procedures). (cf. Exhibit 2, opposite.)

In keeping with this trend, the Aviation Group has been giving increasing attention to passenger safety, which was singled out as a priority area in the 1984 Management Guidelines (cf. Issue 5.2.22). While there is, as yet, no objective standard or method by which to allocate resources between the accident prevention and protection requirements of aircraft safety, a DMSP study is currently underway.

The Regulatory Directorate addresses the problem of aircraft occupant protection largely by means of DAM crashworthiness programs, (standards and surveillance procedures) including standards of fire safety prevention, detection, and suppression, through the DEL passenger safety program, through CASB accident analysis including analysis of coroners' reports, and by means of special studies (DSP, DMSP, etc.)

Regulatory safety programs geared to accident protection often require R&D to provide the necessary data involved in designing standards for airframe crashworthiness, seat and seat occupant restraint systems, cabin interior furnishings, fuel system protection (including anti-misting fuels), cabin fire control/suppression and emergency evacuation systems and procedures. In addition, "soft" R&D may be required to identify problem areas (cf. the DMSP study of passenger safety) or to develop new training programs. (The study of passenger education recently undertaken by the National Transportation Safety Board <NTSB> in the U.S. is an example.)

Review of regulatory programs and program requirements for R&D in this area suggests that the Airworthiness and Aviation Safety Programs Branches will be the major users/sponsors. However, it is possible that the findings of the passenger safety study will lead to recommendations for further study by other regulatory branches (e.g., passenger safety section of DLC). Since Canada is in the process of adopting recent FAA rules relating to cabin safety, rule-making associated R&D is not expected to be the dominant requirement. In addition, the significant R&D effort mounted by the FAA as a result of recommendations by the Special Aviation Fire and Explosion Reduction Committee (SAFER Committee) and other studies will reduce the scope of Canadian requirements. However, Airworthiness Branch believes that there is a continuing need to review the state of the art in crash survivability in terms of new measures which are feasible, practical and effective. They have identified the following thrust areas which require investigation over the longer term:

- Crash resistant fuel systems;
- Aircraft seats and seat support structures;
- Restraint systems (seat belts and harnesses);
- Elimination of "fly-away" cabin materials and objects;
- Passenger smoke masks and hoods. (Study underway.)

Aviation Safety Program Branch (DSP) plans to establish a passenger safety function within the branch which is expected to generate research needs in the following areas:

- Cabin crew procedures and passenger emergency situation response;
- Passenger safety information;
- Professionalism of cabin crews;
- Emergency evacuation procedures.

Detailed study needs will have to await establishment of this function and release of DMSP studies of Management and Passenger Safety Issues respectively.

C. ACCIDENT SURVIVAL AND RECOVERY

Since many of the injuries sustained in aviation accidents are potentially "reversible", additional safety (in terms of lower fatality and impairment rates) may be achieved through programs designed to improve accident response and recovery capabilities. The importance of airport emergency services such as crash fire rescue (CFR) and emergency medical services is underscored by the fact that the majority of aviation accidents (80% worldwide) occur at or near airports. Search and Rescue Programs are also provided to speed the process of locating and assisting the remaining accident victims. Finally, the growing movement of cargo by air makes it imperative to respond effectively to dangerous goods leaks and spills (in addition to fuel spills), a topic that was highlighted at a recent Air Cargo Conference in Los Angeles last April.

The Airports Authority Group is responsible for CFR services and coordinates the efforts of other local agencies involved in providing medical, police and other services in response to aircraft accidents at airports. The Department of Defense and the Canadian Coast Guard are responsible for air and sea Search and Rescue (SAR) respectively. Other departments are also involved (e.g., Departments of Communications and Defense with the SARSAT system). Thus, while regulatory responsibility for standards and safety coordination is largely in the hands of the Regulatory Directorate, operational control of program delivery is primarily the responsibility of other authorities.

This situation tends to limit the scope of regulatory requirements for R&D related to the accident response and recovery phase of the safety cycle. Thus, R&D related to CFR services or service deficiencies would be an Airport responsibility at the present time. (DSP can of course make recommendations in

this regard.) The same is true of R&D related to the operational planning of SAR. On the regulatory side, the major area of regulatory responsibility is the development of standards and regulations relating to the use of electronic locator transmitters (ELT's) aboard Canadian aircraft. This is an area of considerable concern and priority at the present time, (ELT's were given specific mention in the 1984 Management Guidelines). A major problem is performance. Analysis of field data has revealed that up to 95% of ELT signals picked up by Transport Air and Marine radio stations and other sources, and transmitted to Federal Rescue Coordination Centres, are false alarms. Consequently, all signals are initially suspect, and involve a tremendous wastage of time and resources (and potentially human lives as well).

A large body of "R&D" has already been completed on this topic. The most recent was the Report of the Interdepartmental Committee on Locator Devices which made a series of seventeen recommendations in July 1984, several of which involve additional R&D. The most significant for our purposes are the following:

> "Recommendation 2: That Transport Canada, through its Air Administration, and National Defence be jointly requested to examine the ELT performance standards and specifications recommended by the U.S. Radio Technical Commission for Aeronautics (RTCA) to determine whether these standards and specifications will be adequate to meet Canadian conditions. Consideration should also be given to improvements to signal purity and the generation of identifier codes to improve ELT effectiveness.
>
> Recommendation 3: Should it be determined that Canadian conditions warrant standards and specifications which go beyond the RTCA proposals, Transport Canada be requested to sponsor the Department of Communications to undertake the design and development of an acceptable new generation ELT for Canadian type approval. This ELT should be designed to broadcast on 121.5 MHz.
>
> Recommendation 5: That following satisfactory progress to implement recommendations 10 and 11, Transport Canada, in cooperation with the Department of Communications, sponsor the development of a PLB which would meet Transport Canada's standards and specifications and be generally in line with ELT's standards of survivability, power, shelf life, etc. These PLB units should be designed to permit the transmission of

digitized identification information, as well as information which will describe the nature of an incident.

Recommendation 6: That the Department of Regional and Industrial Expansion work with the Department of Communications to develop a suitable Canadian capability to manufacture these new PLB transmitters.

Recommendation 11: That Transport Canada work with the Department of Communications and the Department of Regional and Industrial Expansion to develop the technology and a program strategy, including a Canadian manufacturing capability, to permit the Federal government to sponsor the conversion of aircraft and marine beacons to 406 MHz over the next ten years. Options should be developed, including the use of financial subsidies to ensure full conversion or retrofit can take place at least within the next ten years.

Recommendation 12: That Transport Canada sponsor, through the Department of Communications the conduct of required research and development which would lead to the development of performance standards and specifications and develop and test a prototype device capable of homing in on signals on 406 MHz. In addition, the Department of Regional and Industrial Expansion is requested to examine the possibility of developing a Canadian manufacturing capability to produce these devices."

In addition to the ELT problem, there is some concern about survival equipment. With the exception of Air Navigation Order Series V No. 12 which governs the carriage of survival equipment and protective clothing for flights in an area defined as "sparsely settled", no regulation exists. Special Reports submitted in the past by SAR have identified many cases where survival equipment has been inadequate in the rest of the country where the majority of aircraft operations take place. Dubin recommendation 185 on this subject has been dealt with under the proposed new Aeronautics Act (Bill C-36), but research is needed to determine what kind/quantity of equipment is appropriate for current operating conditions.

D. AVIATION MEDICINE

By MOU of July 1, 1978, the Department of Health and Welfare (HWC) undertakes to provide advice and assistance on aeromedical matters related to medical standards, factors affecting health and safety in air operations, assessment

of medical examinations, and accident and incident investigations. A significant element of this work is R&D performed at the Canadian Aviation Medicine Unit (CAMU) at Downsview, Ontario. As an R&D "performer" the CAM unit studies the medical research requirements of the Canadian Aviation Industry through the interdepartmental National Advisory Committee on Research and Development (the "NACARD Committee"). This Committee is composed of representatives from all major sectors of the aviation industry, including the Regulatory Directorate and the CASB. The following research classifications have been proposed for planning purposes:

Area I:	**Visual/Tactile**	a) evoked potentials
		b) instrument/switches: design, layout, size, shape, colour
		c) neurophycological studies of visual pathways
		d) dark vision
		e) interior cabin design, i.e., exit markings
Area II:	**Auditory**	a) evoked potentials
		b) aural warning systems
		c) difficult radio transmission
		d) hearing tests for definite bottom lining of pilots' safety
Area III:	**Passenger Safety**	a) cabin interior, i.e., materials, lighting, seat pitch
		b) cabin air studies re: smoking
		c) graphite composite materials used in construction - dangers
Area IV:	**Physiology Studies**	a) hypotension
		b) drugs

		c) heat/cold stresses
		d) radiation studies (cosmic)
		e) motion sickness (biofeedback)
		f) colour vision
Area V:	**Helicopter Studies**	a) back problems
		b) vibration/vision
		c) survival-post crash
Area VI:	**Human Factors**	The entire area of human factor related flight safety issues including psychomotor performance and ergonomics.

Area VII: Hypobaric Chamber for both training and research studies.

In addition, an Interdepartmental Task Force was established (January 1985) to identify the safety medical service requirements (including R&D) of Transport Canada (largely AAR/DSP), the CASB and HWC.

As forums for identifying and coordinating aeromedical research efforts, this work will clearly have an important bearing on the manner in which human factors research requirements of regulatory branch organizations are dealt with within the scope of the R&D program. In particular, the assignment of priorities to specific projects will depend in no small measure, on the nature of parallel requirements that might be identified as a result of the above activities.

V. CURRENT R&D DEMAND

The present chapter presents R&D requirements in aircraft safety according to the four principal sponsor/user groups identified within AAR/DSP as follows:

- Regulatory Organizations:
  - Airworthiness (DAB);
  - Licensing and Certification (DLC);
  - Enforcement and Legislation (DEL);
  - Aviation Security (DAX).
- DSP Safety Research and Analysis (SPA);
- DSP Safety Promotion (SPP);
- DSP/DLC Search and Rescue.

In addition the DSP R&D group will be responsible for monitoring and coordinating R&D efforts with Health and Welfare sponsored R&D developed through the Interdepartmental National Advisory Committee on R&D (NACARD), and also with the Airport and Navigation Directorates and CASB. Details are as follows:

A. REGULATORY BRANCH ORGANIZATIONS

Branch Organizations will provide major input for R&D project consideration. Discussions were held with representatives of all the regulatory branches regarding the R&D needs of the respective branch organizations. (cf. Appendix D). Details are as follows:

I) Airworthiness Branch (DAB)

Airworthiness Branch is responsible for the development and implementation of national policies, programs, procedures, legislation and standards to ensure the airworthiness of all civil aircraft and aeronautical products manufactured, operated or registered in Canada, and for initial approvals for all Canadian manufactured products and continuing airworthiness support, wherever operated. The Branch has six main functional groups as follows:

- Airworthiness Standards (ABS), including the Airworthiness Manual Project Group (with DEL);
- Programs (ABP), including Canadair, De Havilland, Pratt and Whitney among others;
- Engineering (ABE), including Structures, Systems, Aerodynamics, Avionics and Power Plants;
- Flight Testing (ABF), including heavy and light aircraft, Balloons, Airships, Rotorcraft, Business Aircraft, Flight Test Engineering;
- Airworthiness Inspection (ABM), including AME licensing, Aircraft maintenance, A/C C of A, Avionics, National Air Carrier Audits;
- Continuing Airworthiness (ABC) including Service Difficulties (SD's), Airworthiness Directives and promotion.

In addition to input from DAB itself, proposals were received and reviewed on a confidential basis from Canadair, De Havilland Aircraft Co. of Canada and Pratt and Whitney Canada. DAB will likely be the most important sponsor/user of R&D among Regulatory Branches, particuarly ABS and ABM groups. The following project proposals were received for consideration and review: (For detailed project descriptions see Appendix A.)

1. Accident Prevention Emphasis

- Aircraft Inspection Study;
- Effects of Hazardous Substances on Aircraft Maintenance Engineers and Airworthiness Inspectors;
- External Loads on Aircraft;
- Helicopter "Bear Paws";

- Computerized Airworthiness Information System Implementation;
- Skiplane Performance;
- Carriage of Bulk Liquids and Cyrogenics;
- Low Level Aircraft Operations.

In addition, it was suggested that thought should be given to investigating the effect of continuous operation of aircraft at low altitudes on the fatigue life of aircraft and aircraft structures; high strength/low weight composite materials to update airworthiness standards; the potential of design factors to reduce the probability and consequences of human error; landing and take-off distances on sub-standard runway surfaces; and the possibility of developing a data base with respect to new generation materials. However, projects can only be developed with respect to these matters when more specific requirements are defined over the longer term and contacts are made to establish whether similar work has been (or could be) undertaken in the United States or elsewhere.

2. Accident Protection Emphasis

Further work has been proposed in the area of passenger protective breathing equipment. Study of the crashworthiness of high wing aircraft; of the integrity of Turbojet and Turboprop engines and propellers; and of seats, seat attachments and support structures under crash loadings, are areas that may have to be developed into specific projects over the longer term.

II) Licensing and Certification Branch (DLC)

The Licensing and Certification Branch is responsible for the development and implementation of national policies, programs, procedures, legislation and standards to ensure that civil aviation aerodromes, facilities, aircraft operations and personnel in Canada are certified, licensed and operated in compliance with regulatory requirements. The Branch has three main functional groups as follows:

- Licensing (LCL), including personnel licensing, aircraft licensing and register, flight training and examinations and licensing standards;
- Air Carrier Certification and Inspection (LCO) including Air Operations Certification, Air Carrier Inspection for large and small aeroplanes and rotorcraft, passenger safety inspection and dangerous goods inspection;

- Inspector/Engineer Training and Development (LIT)

Since 1982, DLC has been cooperating with the FAA Office of Aviation Medicine, the Airline Operator and Pilots Association (AOPA), the General Aviation Manufcturers' Association (GAMA) and the Civil Aviation Authorities of France and Australia, in the area of Pilot Judgement Training. This program of research is planned to be expanded over the next five years with the development of:

- Private Pilot, Instructor and Instrument Manuals (with AOPA);
- Audio Visual Training Material Support;
- Air Taxi Training Materials (3rd/4th level air carriers);
- A methodology to certify "judgement";
- Cockpit Resource Management Manual/Program;
- Basic behavioural studies of risk management, stress management and rehabilitation.

In addition, DLC is currently involved in a broad-based review of the regulatory mandate with respect to ultra-light aircraft. (It is expected that R&D related to Dangerous Goods will in future be the responsibility of the Dangerous Goods Directorate.)

III) Enforcement and Legislation Branch (DEL)

Enforcement and Legislation Branch is responsible for the development and maintenance of aeronautical legislation; development and management of the aeronautical regulatory enforcement programs; development and standardization of aeronautical terminology; and management of the Aeronautics Act Task Force legislative review. It consists of four main sections:

- Legislation and Regulations, including ICAO liaison;
- Aviation Enforcement;
- Aeronautical Terminology (bilingualization programs);
- Aeronautics Act Task Force, including work on Canadian Civil Aeronautics Code and Airworthiness Manual.

The following projects were identified in consultation with DEL.

- Evaluation of Enforcement Surveillance Activities;
- Evaluation of Effectiveness of Sanctions;
- Development of a profile of repeat offenders;
- Development of psychological profiles of pilots involved in air accidents to distinguish behavioral characteristics of those with extensive violation history;
- Study of External Loads on Aircraft.

IV) Aviation Security Branch (DAX)

Aviation Security Branch is responsible for implementing legislation, policies, programs, procedures and standards to ensure that a level of aviation security compatible with international requirements is provided for the travelling public by Canadian carriers, Canadian airports, foreign carriers operating in Canada and foreign airports being used by carriers coming into Canada. It is a small group of four people, including the Director and his secretary.

DAX recently sponsored a "Continuous Vapour Detector" research project which has been conducted by the NRC over the past two years. Additional projects of interest in the future include:

- Research to test the feasibility of introducing automatic alerting mechanisms at the passenger screening checkpoint, to reduce the need for 100% monitoring;
- Passenger and Baggage Matching System;
- Criteria development for Selection, Training and Certification of Security Personnel.

Responsibility for developing and implementing these projects is currently vested in the newly activated Committee for Aviation Security which includes participation of a number of other groups (FSC, KSP), the RCMP and the airlines. However, coordination should be the responsibility of the DSP R&D coordinator.

B. DSP SAFETY RESEARCH AND ANALYSIS SECTION (DSP/SPA)

The second major sponsor/user group for regulatory R&D is the Safety Research and Analysis Section of DSP. As already indicated (Page II.4) SPA is responsible for the planning and development of cost effective safety remedial actions and programs. This is undertaken primarily as a result of evaluation of CASB safety recommendations and in-house identification of aviation safety problem areas as a result of system deficiency analysis or special studies. These remedial actions and programs can take one of four forms:

- Safety promotion and education campaigns;
- Recommendations for administrative action by Aviation Group organizations;
- Recommendations for corrective action by other members of the Canadian aviation community system (voluntary self-regulation);
- Recommendations to amend or develop new statutory requirements (ANO's, standards, regulations) and the necessary inspection/surveillance, licensing, certification and enforcement actions that go with them (i.e., mandatory regulation).

Greater emphasis in recent years has been given to the kind of voluntary (non-regulatory) compliance programs implemented through SPP. However, regulatory action remains important in providing a baseline of minimum acceptable standards.

It is difficult to anticipate the R&D needs of the SPA. Corrective response in any of the above areas could require R&D support. Typically, research or development could be proposed as a solution to a recognized system deficiency, to fulfill a specific requirement in the area of passenger safety or in response to a recommendation of the CASB. SPA identifies system deficiencies according to a classification into five primary causal elements, personnel, equipment (which includes terminal and way as well as vehicle components), environment, management deficiency and aviation operational

management deficiency. These are in turn broken down further into sub-system and system component elements.

As indicated in the previous chapter, the current emphasis is being directed to establishment of management directions/goals/structures and the necessary information and technical systems required to fulfill the mandate developed from current studies by DMSP. In addition, a number of R&D requirements are expected to be identified as a result of the current study into passenger safety. In the interim, the following R&D projects have been proposed:

- Safety Management Planning Study;
- Identification, Development and Coordinating of Information Needs for "SAFE" Program;
- Evaluation of "SAFE" Program Functional Classifications;
- Definition of Passenger Safety R&D Requirements identified by DMSP Passenger Safety Study.

C. DSP SAFETY PROMOTION SECTION (DSP/SPP)

The Safety Promotion Section emphasizes the dissemination of safety information and the propagation and development of safety awareness and voluntary adherence to general principles of good (i.e., safe) conduct among members of the aviation community. R&D requirements at the present time are limited to the following two project proposals:

- Determination of Educational Requirements for Passenger Education Program;
- Safety Behaviour Modification Study.

D. DSP/DLC SEARCH AND RESCUE SECTIONS

The two major factors which determine the success of the SAR mission are:

- The speed with which survivors can be located and, in the event of a delay;
- Their ability to sustain life until they can be rescued.

The first is dependent in part on the existence aboard the aircraft of a viable emergency locator transmitter (ELT) capable of alerting the nearest SAR Rescue Coordination Centre (RCC). The second is dependent in part, on the existence of adequate food, emergency equipment and protective clothing, to enable the accident victim to survive until help arrives (particularly in sparsely settled areas in winter). In both cases, existing regulations have been criticized for being out-of-date. In the case of the ELT, certain international developments (development of SAR Satellite Aided Tracking or SARSAT System and recommendations of the U.S. Radio Technical Commission for Aeronautics <RTCA> among others) have prompted the need for an early decision. In the case of the Sparsely Settled Areas ANO (Series V, No. 12) the regulations are fifty years old and are considered out-of-step with current location techniques.

In the light of these requirements, two projects for R&D have been identified:

- Policy study/decision to determine carriage policy for new generation of ELT's;
- R&D to provide technical basis for updating current ANO with respect to survival equipment requirements for aircraft.

Transport Canada is not responsible for R&D required to support or improve the operational aspects of the SAR function.

VI. R&D SUPPLY

Demand for R&D products required by Regulatory branch organizations may be met in a variety of ways. The present chapter provides an overview of the management options available, and also of the performers that may be called upon to conduct the work. The options available to management are threefold. Thus, R&D needs may be supplied:

- in-house
- cooperatively with others
- exclusively by others and made available:
  - free (e.g., as published reports)
  - under contract

R&D resources available in-house are limited, and it is not expected that this option will be extensively pursued. In addition to in-house resources, the Management Systems group of Transport Canada has performed planning and systems-related R&D on behalf of regulatory branch organizations (Passenger safety work, etc.)

Considerable scope exists for cooperative work performed with regulatory and non-regulatory organizations in other countries. Administrative vehicles for this work include:

- The McLeish/Helms agreement with the FAA (Addendum No. 4 to the Jamieson/Volpe MOU of June 18, 1970. This is currently being renegotiated);
- The CATA/FAA Bilateral Airworthiness Agreement;
- Similar Administrative Arrangements with France, U.K. Australia, etc.

Joint Research Project Arrangements (JRPA's) are currently in force with the FAA regarding Pilot Judgement Training, and Aviation Security.

Finally, Regulatory branch requirements for R&D may be supplied by external organizations working for their own account or under contract to the Regulatory Directorate. Canada is fortunate in the degree to which information required to support regulatory decision-making and safety enhancement programs is freely available through the published reports of foreign regulatory and other authorities, particularly the Federal Aviation Administration (FAA) in the United States. Clearly, duplication of effort must be avoided at all costs, and the relevant regulatory and aviation safety sections of the August 14, 1985 draft FAA "Plan for Research, Engineering and Development" constitute a major planning input to R&D program planning (cf. below).

A major part of the program is likely to consist of contract work performed by Canadian government research establishments, private research and consulting groups and the universities. Some joint work with the FAA might involve co-operation with FAA (and possibly other U.S. and foreign) research establishments. In view of the importance of the FAA, both in terms of defining the content of Canadian R&D program requirements and in terms of R&D performance capabilities, this topic will be taken up in the following section.

A. FAA R&D PROGRAMS AND PERFORMANCE CAPABILITIES

Canadian R&D program planning must be coordinated with FAA planning thrusts in order to avoid duplication of efforts, to identify those areas of common interest that could be developed jointly, and to more readily identify those specific Canadian R&D requirements that must be performed by Canada. Fortunately, the FAA is currently in the course of developing a comprehensive plan of its own which covers all aspects of this organization's R&D (or "R, E and D") requirements, including that portion of R&D required to support air navigation and airport safety and capacity plans, as well as aviation safety and regulatory planning requirements. The plan, entitled **"Federal Aviation Administration's Plan for Researach Engineering and Development"**, has a number of objectives related to the terminal, way and vehicle environment, designed to:

- improve NAS system capacity by technologies and procedures designed to increase the capacity of existing bottlenecks (largely terminal/runway) facilities;
- improve NAS system productivity by technologies and procedures designed to provide users with a more flexible "way" (offering user-preferred routes, etc.);
- improve NAS system coverage by extending the "way" system to new airspace (low altitude, oceanic and remote areas) and to new airspace user categories (G.A. rotorcraft, etc.);
- improve NAS system safety through R&D designed to provide ongoing support to FAA operational, regulatory and safety programs.

These objectives and others related to the environment, freedom of flight, etc. are inter-related to a considerable degree. Most programs of specific relevance to the present study are contained in the category of "Sustaining R, E & D Activities" and include:

- Aircraft Safety*
- Aviation Medicine*
- Aviation Security*
- Technology Development*

1. Aircraft Safety (Volume II, Chapter 11)

The Aircraft Safety Program (Program Plan No. APM-710, Donald A. Schroeder Program Manager) as its name implies, is mainly concerned with the vehicle component of the aviation system. It is divided into three main segments: Airworthiness, Crashworthiness and Regulation Development Support.

* Readers are referred to Chapters 11 to 14 of Volume II of the Draft FAA Plan for Research, Engineering and Development of August 14, 1985, for further details.

The Airworthiness area stresses accident prevention and includes activities such as the establishment of airworthiness criteria for aircraft structures and propulsion systems, assessment of atmospheric and electrical hazards, development of icing certification criteria, and development of guidelines for certification and maintenance of onboard hardware and software.

The Crashworthiness area stresses the protection aspect of passenger and crew impact and post-crash safety.* It includes activities such as development of flammability and toxicity criteria for materials, detection and control of onboard fires, evaluation of seat structures and passenger restraint systems under dynamic crash loads, and development of emergency procedures.

The Regulatory Development Support area stresses the development of technical data, guidelines, and test equipment techniques and procedures in support of ongoing regulatory developments, aircraft certification, and safety-related activities in other government agencies. This program is also responsible for keeping abreast of the safety implications of technology developments in the fields of aerodynamics, propulsion, structures, materials, guidance, navigation and control.

2. Aviation Medicine (Volume II, Chapter 12)

The Aviation Medicine R&D Program is primarily concerned with the human component of the NAS. The program is a support activity which responds to specific requirements of agency divisions such as Air Traffic, Personnel and Training, Flight Operations, Airworthiness

* FAA R&D requirements in this area are based in part on the recommendations of the Special Aviation Fire and Explosion Reduction (SAFER) Advisory Committee Report of 1980.

and others. Research efforts are conducted by the Civil Aeromedical Institute (CAMI) or outside organizations under contract to the Office of Aviation Medicine. The major objectives are to:

- develop comprehensive, statistical and conceptual data-based systems to optimize productivity and performance of the agency operational work force at a minimum cost to the public;
- develop procedures and analytical techniques to reduce human errors in airspace management;
- develop appropriate medical standards for airmen and agency operational personnel, and maintain a high level of occupational health and safety standards in a cost-effective manner;
- reduce the potential for injury or loss of life following aircraft accidents or incidents.

The program is thus aimed at promoting not only the safety of Civil Aviation, but the health, safety and efficiency of the FAA work force. In the Civil Aviation Safety area, attention is given to the human causes of accidents as well as to the potential for protecting aircraft occupants against accidents once they have occurred.*

The preventive aspect involves comprehensive human performance studies leading to identification and analysis of pilot error associated with deficiencies in training, proficiency, equipment and systems design, management, and judgement. Major efforts are currently underway to evaluate judgement training for airmen in cooperation with CATA Licensing and Certification Branch (DLC). Additional work includes:

- Human Error Analysis;
- Airmen Cockpit Performance;

* FAA requirements for human factors research are based on the issues and recommendations presented at the six Human Factors Workshops held by the FAA during 1981.

- Pilot/Controiler Interface;
- Cockpit Certification Criteria for Advanced Transports;
- Human Performance Studies.

Protection and survival of accident victims (passengers and crew) is the responsibility of the Protection and Survival Program conducted in cooperation with airspace users and industry. The approach is two-fold:

- support rule-making and certification actions by evaluating the benefits and costs (merits and demerits) of specific safety-related equipment and procedures, and
- promote the proper use of this equipment through educational initiatives.

Recent studies have focussed on the following problem areas:

- **Seat and Seat Restraint Testing** in support of crashworthiness determinations;
- **Water Survival Studies** to develop viable and cost-effective water survival concepts and procedures, equipment standards and performance criteria for seat cushion buoyancy and SAR requirements;
- **Protective Breathing Equipment Studies** to improve the technical standards of such equipment for crew and passengers;
- **Toxicity Studies** to develop reasonable standards for cabin interior materials;
- **Evacuation Studies** in support of other FAA development programs.

In addition, the Aviation Medicine Program provides research and support for the Federal Air Surgeon with respect to airman medical certification and standards, medical accident investigation and usage of therapeutic drugs by aviation personnel. For example, a two-year review of the aeromedical standards of FAR Part 67 will shortly be undertaken.

3. Aviation Security (Volume II, Chapter 13)

The Aviation Security R&D Program is designed to meet the Congressional Requirement of Public Law 93-366 to ".... conduct such research (including behavioural research) and development as he may seem appropriate to develop, modify, test, and evaluate systems, procedures, facilities, and devices to protect persons and property aboard aircraft in air transportation or intrastate air transportation against acts of criminal violence or aircraft piracy". The objectives of the program are to:

- develop improved systems for the detection of explosives in air cargo, checked baggage, aircraft, and the terminal;
- further improvements in concourse security;
- evaluate operationally viable responses to in-flight bomb threats.

This program is also based on the twin concepts of prevention (i.e., detection) and protection. The two major prevention programs are:

- **Concourse Security** to develop improved systems for detecting passenger and hand-carried baggage, weapons and explosives. This project has three parts:
  - fast neutron interrogation
  - thermal neutron systems
  - new technologies
- **Enhanced Bomb Detection** to develop explosive additives and associated detection procedures which will render terrorist explosive devices readily detectable:
  - first generation system
  - second generation system

The Canadian Civil Aviation Security Branch (DAX) and the FAA Office of Aviation Security already cooperate in a Joint Research Project Arrangement signed March 22, 1982. Transport Canada is

taking the lead role in research on vapour trace detection of explosives on passengers, in carry-on and checked baggage and cargo and in investigation of human factors considerations and technical advances for access control systems.

The major protection activity is the In-Flight Bomb Response Project designed to develop and validate procedures for flight crew to deal with an explosive device found aboard the aircraft. Attention is directed to:

- Risk Analysis
- Jettison Feasibility
- Damage Containment

Finally, a Security System Integration program/project has been established to integrate all aspects of airport security and to identify and preclude any "windows of vulnerability".

4. Technology Development Program

The Technology Development Program is a long-term program to develop promising new areas for aeronautical technology.* Included are those cockpit human factors research projects required to ensure that new avionics and the cockpit procedures occasioned by increased automation, are property developed. Current flight deck and display certification decisions based on the subjective assessment of test pilots must be replaced by more objective standards of performance and design specifications developed through carefully tailored investigations of the interface between man and machine. Digital avionic, flight control systems and displays are expected to have major

* R&D requirements with respect to the certification implications of these technological advances were originally identified through a joint FAA/NASA study in 1977.

impacts on pilot performance, workload, crew coordination, air to ground communications, and crew training requirements. This will be an area of cooperative research with organizations such as the NASA, National Science Foundation and the Defense Department. Projects of major interest to Canada would include the following:

- **Flight Crew Training Enhancements** will upgrade flight crew training programs to:
  - increase crew skill
  - increase effectiveness of line-oriented flight training
  - improve effectiveness of communications
  - decrease training costs
- **Behavioral Certification Criteria for Cockpits** will develop methods and quantitative behavioural criteria for certifying advanced technology cockpit display and control systems;
- **Advanced Technology Cockpit** will ensure the ability of flight crew to use and control manual and automated flight control systems (e.g., flight phase status monitoring) and provide compatibility with the NAS ("way") system;
- **Rotorcraft Display and Control Standards and IFR Requirements** will develop crew performance criteria to evaluate and to certify new cockpit display and control technology.

A similar human factors program has been established with respect to the ATC system.

5. F.A.A. R&D Performance

The present institutional structure for funding and performance of U.S. aeronautical research and development may be summarized very briefly as follows:

- The FAA, with NASA and DOD support, is responsible for air traffic control and safety-related aeronautical R&D.

- DOD funds, directs, and implements aeronautical technology development and demonstration programs directed specifically toward military applications.
- NASA funds, directs, and implements aeronautical research and development programs and supports military aeronautical technology demonstration programs.
- NASA and DOD encourage transfer of aeronautical research results to and within U.S. industry.
- FAA, DOD and NASA all manage, maintain, and operate aeronautical research, development, test, and evaluation facilities.

The FAA uses by far the largest share of the total DOT R&D budget, $304 million of the total of $519 million in 1984 (58.5%). This work is performed both in-house, jointly with other organizations, (including Transport Canada and on contract. It is considered desirable to contract for R&D work when:

- the expertise required is highly specialized and of a temporary nature;
- the research work requires extensive field operations over a large geographic area;
- special facilities are required which already exist in other government agencies, in universities or in the private sector;
- there is a peak workload in one area of activity.

However, because of the volume of R&D activities, the FAA attempts to maintain in-house staff competence in special technologies considered vital to the fulfillment of mission objectives (such as safety). Establishments such as the National Aviation Facilities Experimental Centre (NAFEC), a 6,000 acre complex in Atlantic City and the Civil Aeromedical Institute (CAMI) at Oklahoma City are unique facilities with unique capabilities which can often provide more timely results than would be possible through the contracting out process. In addition, the DOT's Transportation Systems Centre (TSC) in Cambridge,

Massachusetts performs R&D on behalf of the FAA (e.g., Development of the Aviation Safety Analysis or ASAS system).

B. CANADIAN AERONAUTICAL R&D POLICY AND PERFORMANCE

Treasury Board policy since the 1970's requires that whenever appropriate, government research needs should be met by the private sector rather than "in-house". This view was reemphasized recently in the Report of the Task Force on Federal Policies and Programs for Technology Development", July 1984 (The Wright Report), which stated that **".... R&D should only be done in-house when there is a need for secrecy and neutrality, or when contracting out is not cost-effective in the long run"**, (Page 31). While the following summary listing of Canadian research establishments might appear to over-emphasize the role of government owned and government operated (GOGO) facilities, these are likely to continue to play a major role in meeting the R&D needs of regulatory branch organizations for the five-year period under review. Additional detail for these and other potential R&D performers may be obtained from the DGRD Draft Discussion Paper entitled **"A Framework for Research and Development in Aeronautics"**.

1. Transport Canada Aviation Group

The Aviation Group operates four facilities as follows:

- ATS Research and Experimentation Centre, established to study problems of airspace planning and management and air traffic control, (in support of DGAN requirements);
- Engineering Systems Laboratory, established to design, develop and test electronic devices and systems;
- Development/Maintenance Centre, established to provide configuration management of designated computer-based systems in the field;
- Airport Facilities Branch, DKF, Materials Laboratory, (in support of Airport requirements).

2. Canadian Aviation Safety Board (CASB)

- Aviation Safety Engineering Facility (Ottawa Airport). This facility is primarily oriented to accident investigation.

3. National Research Council (NRC)

- National Aeronauticai Establishment (Ottawa), the largest single aeronautical research establishment in Canada. The major facilities include:
  - wind tunnels
  - airborne facilities
  - high speed aerodynamics laboratory
  - low speed aerodynamics laboratory
  - unsteady aerodynamics laboratory
  - structure and materials laboratory
- Division of Mechanical Engineering;
- Division of Electrical Engineering;
- Industrial Materials Research Institute (Boucherville, Quebec)

4. Health and Welfare Canada

- Civil Aviation Medical Unit (CAMU), Downsview, Ontario

5. Department of National Defense

The Chief of Research and Development (CRAD) of DND operates six research laboratories as follows:

- Defense Research Establishment Atlantic, (DREA), Dartmouth, Nova Scotia;
- Defense Research Establishment Valcartier (DREV), Valcartier, Quebec;
- Defense Research Establishment, Ottawa (DREO), co-located with the Communications Research Centre at Shirley's Bay, Ontario;

- Defense Research Establishment Suffield (DRES), Suffield, Alberta;
- Defense Research Establishment Pacific (DREP), Sydney, B.C.;
- Defence and Civil Institute of Environmental Medicine (DCIEM), co-located with the CAMU at Downsview, Ontario.

The Chief of Operational Research and Analysis (CORAE) has an impressive operations research capability which could provide assistance in certain R&D need areas.

In addition, test and evaluation facilities managed by Operational Commands include:

- Aerospace Engineering and Test Establishment (AETE), Cold Lake, Alberta (Air Command);
- Primrose Lake Weapons Range;
- Maritime Proving and Evaluation Unit, Greenwood, Nova Scotia;
- Quality Engineering Test Establishment (QETE), Hull, Quebec.

6. Department of Communications (DOC)

- Communications Research Centre (CRC), Shirley Bay, Ontario.

7. Provincial Research Organizations

- Alberta Research Council, Edmonton, Alberta;
- B.C. Research, Vancouver, B.C.;
- Centre de Recherche Industrielle de Québec (CRIQ), Ste-Foy, Quebec;
- Manitoba Research Council, Winnipeg, Manitoba;

- New Brunswick Research and Productivity Council, Fredericton, N.B.;
- Nova Scotia Research Foundation Corporation, Dartmouth, Nova Scotia;
- Ontario Research Foundation, Mississauga, Ontario;
- Saskatchewan Research Council, Saskatoon, Saskatchewan.

8. Canadian Universities

- University of Toronto Institute for Aerospace Studies, Toronto, Ontario;
- Ecole Polytechnique de Montréal, Montréal, Québec;
- Université de Montréal, Centre de recherche sur les transports (CRT).

VII. STRATEGIC PROGRAM DEVELOPMENT

Previous sections of this report have described:

- An initial framework for safety program development based on
  - aviation safety areas (prevention, protection and survival);
  - regulatory support areas (rule-making, NCATS monitoring and surveillance, management support);
  - offices of primary interest (OPI's).
- Potential (i.e., longer term) R&D program thrusts;
- R&D projects. (cf. Appendices A and B for descriptions and ranking) and performing organizations.

Project development, evaluation and selection will have to be continually reviewed, improved and updated by the eventual DSP R&D group with the aim of increasing the effectiveness and efficiency of R&D, in attaining the Aviation Group's goals and objectives. Goals and objectives themselves must be improved upon in the light of changing circumstances, and R&D may also be necessary to refine the decision criteria and enhance methods of evaluation and selection as presented in Appendix B. Such projects in turn also become subject to evaluation and selection.

The key program elements and certain major issues that will have to be taken into account in implementing the R&D Program are as follows:

PROGRAM ELEMENTS

The proposed R&D Program for the Regulatory Directorate may be regarded as combining:

- Projects
- Schedules
- Resoures
- Organization
- Management

1. Projects

The various projects identified by review of DGAR Branch requirements, detailed in Appendix A, may be summarized as follows:

Sponsoring Branch Organization	Number of Projects	Estimated Cost ($)
• Airworthiness Branch	9	1,123,000
• Aviation Security Branch	4	1,005,000
• Licensing and Certification Branch	7	470,000
• Aviation Safety Programs Branch	7	200,000
• Enforcement and Legislation Branch	6	190,000
Total DGAR:	**33**	**2,988,000**

In addition to these projects, which constitute the more immediate (0-2 years) requirements of the DGAR, the Program will subsequently embody a series of projects over the longer term (2-5 years) which cannot be defined at the present (incipient) phase of Program development. However, based on the findings documented in Chapter IV, it is evident that the major part of ongoing project requirements will be used primarily to provide decision support for the rule-making function of DGAR. At the present time this is devoted largely to accident prevention, although increased attention is expected to be given to passenger safety (i.e., protection and survival) aspects of aviation safety maintenance and enhancement. The absense of safety goals or other objective cri-

teria by which to determine safety resource allocation priorities and to provide direction and coherence to safety programs as a whole, including regulatory programs and attendant R&D support requirements, prompted the design of a specific R&D project in this area.

Improvement of the evaluation and selection process will also be a responsibility of the R&D Group. While the selection of R&D projects will in large part depend on decision criteria such as benefits potential, risk assessment and resource burden, it may be difficult to estimate those factors at the beginning of an R&D project. In such cases, R&D programs can be segmented into subprograms which, when completed, will serve to provide improved estimates for program reevaluation.

2. Schedules

Program scheduling will depend on the level of funding to be made available for Program implementation. However, with the exception of certain big ticket items such as the High Speed Explosives Detector, and the CAIS system implementation, a majority of projects can be completed within the space of a single fiscal year.

3. Resources

Implementation of the project will depend largely on the human and financial resources that will be made available to conduct the work. One person-year has already been committed to manage the Program within DSP. However, no financial plans or commitments have been put forward to date. Following the A-Base Review, the current Management Study should provide the necessary forum for reviewing such requirements in due course.

4. Safety Organization

The present R&D Program has been developed to reflect existing organizational responsibilities, procedures and reporting relationships. (DSP reports through the Regulatory Directorate but has an additional reporting link to the Assistant Deputy Minister, Air.) However, the A-Base Review was of the view that "It may be desirable to reassess in the future, the reporting structure for the Aviation Safety Programs function". Any subsequent change in reporting relationship or organizational responsibility of DSP (e.g., along the lines of the FAA Office of Aviation Safety which reports directly to the FAA Administrator) will clearly have significant implications for the scope of the R&D Program.

5. Program Management

R&D Program management includes the decision-making process which governs the manner in which projects are selected, evaluated and scheduled for implementation. This is a key issue for certain officials who voiced concern that Branch organizations will lose control over the destiny of projects they hold dear. The current management study is expected to give the necessary attention to this and other organizational and resource issues discussed above. The proposed R&D Group within DSP must be given the resources required for the development and improvement of tools for the management of the R&D process. These could include the following:

- Provision of clear description of goals/objectives that will facilitate the R&D management process;
- Optimal selection of Review Panel members;
- Improved identification of system deficiencies;
- Maximization of resources through the identification, retrieval, organization, and dissemination of knowledge/information developed by other sources, e.g., FAA;
- Improved Decision Criteria development and weighting;

- Review and improvement of existing R&D projects evaluation/ selection methods;
- Development of new R&D project evaluation/selection methods.

As mentioned previously, these activities themselves must go through an evaluation and selection process.

KEY PROGRAM ISSUES

Investigation and discussions conducted during the course of this study suggest that the success of Program implementation, measured in terms of its credibility and acceptance by Branch organizations as much as Program performance in terms of the specific benefits to be achieved, will depend on the resolution of certain key issues. These include:

- Concern over the level of funding that may (or may not) be made available to ensure the credibility and the success of the R&D Program. A serious wall of cynicism was encounted within Branch organizations on this score;
- Concern over R&D Program management, specifically over potential loss of Branch control over Program and project priorities;
- Concern that increased "bureaucratization" could delay approval and funding of urgent requirements;
- Differences over the notion of R&D. In spite of a DM Circular on the subject, there is considerable debate as to what is and what is not R&D among Branch organizations;
- Differences over the notion of "safety", specifically with respect to safety objectives and priorities beyond the notion of "adequacy" and the shifting sands of public opinion and media attention.

In addition, it is evident that the Safety Analysis and Functional Evaluation (SAFE) System, currently under development at DSP, will become an integral part of ongoing safety program development as a whole to the extent that it is able to fulfill its mission to identify system deficiencies (safety problem areas)

and to provide the tools needed to design the appropriate countermeasures, including R&D if required. It is for this reason that two projects were identified to provide support for this important safety monitor.

In conclusion, it should be repeated that the Program structure proposed here is only the first step in a continuous process of evaluation and update of Program priorities. Additional evaluation criteria may (and probably should) be introduced as required by Program management, and periodic reappraisal of priorities will be required as new program elements (projects) are introduced into the Program mix.

APPENDIX A

PROJECT DESCRIPTIONS

(in rank order)

PROJECT DESCRIPTION SHEET NO. 1

(November 1985)

PROJECT: Continuous or High Speed Explosives Vapour Detector (HSEVD)

OPI: DAX/L

BACKGROUND

Canada has taken a lead role in the development of Vapour Detectors for explosives and other substances, including drugs, due primarily to the efforts of the National Research Council and the CATA. An explosive detector has already been developed and is in use at major Canadian airports. However, while this device can be used for bomb threats, etc. it is inadequate for passenger-searching because of the two-minute turn-around involved. The HSEVD is based on a four-stage concept:

- Continuous Action Preconcentrator (CAP);
- Separation (explosive compounds);
- Detection (various techniques);
- Processing.

Once developed the HSEVD could be adapted for both "on-board" and "last point" detection, two priority areas indicated by the Minister of Transport, Don Mazankowski, in an address to the International Civil Aviation Organization in Montreal, on June 27, 1985.

PROJECT OBJECTIVE

Development of a High Speed Explosive Vapour Detector capable of detecting explosives and other materials at walk through or X-Ray search points within five seconds.

CURRENT STATUS

The National Research Council (NRC) has been working on this project on behalf of the CATA for the past three years. A Continuous Action Preconcentrator (CAP) has been developed by NRC (M-10 laboratory). TDC is planning to study the feasibility of using High Speed Gas Chromatography (HSGC), based on an unsollicited proposal received from Scintrex Ltd. of Toronto. Other possibilities that could be used include Ion Mobility Spectrometry (Barringer proposal) and Mass Spectrometry (Sciex proposal). The latter proposal is being pursued by the Department of Regional Industrial Expansion (DRIE).

FUTURE PLANS

Approximately two more years of research are anticipated before results can be turned over to industry for industrial development and manufacture.

ESTIMATED COST

$250,000 per year for two years.

TIME FRAME

Two years.

R&D PERFORMANCE

Private contractor.

PROJECT DESCRIPTION SHEET NO. 2

(November 1985)

PROJECT: X-Ray Security Screening System to Provide Limited Automation of the Passenger Screening Checkpoint.

OPI: DAX/L

BACKGROUND

Air Carriers currently require four guards at a busy checkpoint to monitor equipment and search as required. The CATA is responsible for the provision, installation and maintenance of the necessary passenger screening equipment. The monitoring process could be much improved through development and employment of an automatic alerting system. In addition, such a system would reduce manning requirements to two guards and eliminate some of the tedium involved in this work.

PROJECT OBJECTIVE

Develop/implement automatic security X-Ray screening system at busy checkpoints to eliminate the need for 100% monitoring.

CURRENT STATUS

A contract to demonstrate the technical feasibility of an X-Ray Security Screening System was awarded to Roy Ball Associates Ltd., on August 14, 1985. Total cost for the year-long study will be $275,000.

FUTURE PLANS

Final report will document the configuration design, specifying hardware components and presenting program listings of all software developed. A program plan will be presented detailing subsequent development work, including costs, tasks to be performed and schedules.

ESTIMATED COST

- Technical Feasibility Phase - $275,000;
- Development/Test/Demonstration - to be determined.

TIME FRAME

- Technical Feasibility Phase - One year;
- Development/Test/Demonstration - To be determined.

R&D PERFORMANCE

Private contractor.

PROJECT DESCRIPTION SHEET NO. 3

(November 1985)

PROJECT: Emergency Locator Transmitter (ELT) Carriage Policy Development

OPI: DSP/L

BACKGROUND

Current regulations (Emergency Locator Transmitter Order - ANO Series II No. 17) require all aircraft (with certain exemptions) to be equipped with an approved ELT transmitting on 121.5 MH_z or on 121.5 MH_z and 243.0 MH_z. International developments, specifically the SAR Satellite Aided Tracking (SARSAT) proposal, U.S. work by the Radio Technical Commission for Aeronautics (RTCA) and new developments towards a third generation ELT broadcasting on 406 MH_z, prompt the need for review of regulatory requirements. This is particularly urgent in view of low level of reliability of current ELT installations.

OBJECTIVE OF WORK

Make recommendations to Minister regarding future ELT carriage policy.

PROJECT DESCRIPTION

An interdepartment study is proposed which would, among other things, consist of the following tasks:

- Review recent studies and proposals regarding SAR location and detection;
- Review national and international developments regarding SARSAT and U.S. RTCA work;
- Consult with Aviation Community;
- Evaluate technical and economic benefits and costs of alternatives;
- Recommend policy for future ELT carriage and phased strategy for implementation.

CURRENT STATUS

Action plan proposed by Interdepartmental Committee on Locator Devices (Report of July 10, 1984).

PRODUCTS

Technical and economic data in support of recommendations for new rule-making.

ESTIMATED COST ($)

Estimated cost is $30,000.

TIME FRAME

Two months.

R&D PERFORMANCE

In-house.

PROJECT DESCRIPTION SHEET NO. 4

(November 1985)

PROJECT: Passenger and Baggage Matching System.

OPI: DAX/L

BACKGROUND

Two recent catastrophes, that of Air India Flight 182 on June 23, 1985, and that of CP Air Flight 003 at Tokyo Narita Airport the same day, served to highlight the potential security threat represented by unaccompanied airline baggage. As a result, the IATA convened a meeting in Amsterdam during the week of July 22, 1985 to discuss the matter. Plans were laid to prohibit the interlining of baggage on international flights.

In Canada, the Minister of Transport, Don Mazankowski, in a speech to the International Civil Aviation Organization in Montreal on June 27, 1985, identified this problem as a priority candidate for R&D. Subsequently, the newly activated R&D Committee on Aviation Security meeting of July 22, 1985 agreed to give high priority to the development of a computerized system to prevent unaccompanied baggge from being carried aboard an aircraft. This would be a highly visible system to act as a deterrant to unlawful interference.

PROJECT OBJECTIVE

Develop a computerized system capable of detecting/identifying baggage which is not accompanied by a passenger on the same flight.

PROJECT DESCRIPTION

The project could be developed as a cooperative venture with the airlines. The initial steps involved would include establishment of joint working group to develop a study design based on operating requirements and specifications. Study could be funded jointly (perhaps through IATA).

PRODUCT

Systems and procedures to detect, identify and remove unaccompanied baggage prior to flight departure.

ESTIMATED COST

$200,000.

TIME FRAME

Two to three years.

R&D PERFORMANCE

Private contractor.

PROJECT DESCRIPTION SHEET NO. 5

(November 1985)

PROJECT: Safety Management Planning Study

OPI: DSP/L

BACKGROUND

The 1985 Management Guidelines indicates that, "the primary aim of our regulatory efforts is to pursue the first and most important of the CATA strategic objectives, safety". While safety must be "adequate" there is no definition or commonly accepted notion of what is meant by the term "safety", and no safety criteria which could assist management allocation of scarce human and financial resources to the various components of safety such as accident prevention (e.g., "flight safety"), saving the lives of accident victims (crashworthiness/aircraft occupant safety) or assuring continued survival by providing prompt response at the scene of the accident occurrence (CFR, SAR requirements, etc.). There are also no criteria by which to determine the safety support requirements for various classes of user (e.g., commercial, private, rotorcraft, etc.), or classes of accident (undershoot, engine failure), or phases of flight (take off, approach/landing, en route, ground, etc.) or types of cause (pilot error, environmental factors, etc.). Consequently, there are few criteria and little other relevant information for assisting senior management in determining safety resource allocations among the three Directorates (AAA, AAN, AAR) responsible for the various aspects of "safety".

OBJECTIVE

Develop safety guidelines and criteria to assist allocation of safety resources by senior management of CATA.

PROJECT DESCRIPTION

The project should consist of the following tasks:

- Review all current CATA safety policies, programs and objectives, whether explicit or implicit;
- Review approaches to safety planning used by other Civil Aviation Authorities, particularly FAA, Civil Aviation Authority of U.K., Scandinavians, etc;
- Develop standard notions, terminologies, and definitions to be employed in "safety" planning and resource allocation;
- Develop safety guidelines and criteria to be used in establishment of safety needs and goals at the required level of detail/disaggregation;
- Modify/adapt current programs for identifying "safety deficiencies" (e.g., SAFE Program, CASB/ASTRA Programs, etc.) to provide relevant information for management decision-making.

PRODUCTS

Common notions, guidelines and criteria, and a safety planning framework to assist senior management decision-making.

ESTIMATED COST

Approximate cost $50,000.

TIME FRAME

Six months. Could be ongoing.

R&D PERFORMANCE

Private contractor or in-house.

PROJECT DESCRIPTION SHEET NO. 6

(November 1985)

PROJECT: Update Private Pilot, Instructor and Instrument Manuals.

OPI: DLC/L

BACKGROUND

The private pilot and instructor manuals have been tested in various programs in the United States, Canada and France in order to asses their effectiveness. Results have been very favorable.

OBJECTIVE

To update the referred to manuals with suggestions that have been made during experimentation.

PROJECT DESCRIPTION

These training materials will address those factors that effect private pilots, instructors and instrument rated pilots in their decision-making skills.

PRODUCT

Training materials oriented around the particular needs of these pilot groups.

ESTIMATED COST

$50,000.

TIME FRAME

6 months private pilot manuals

10 months instructor manuals

12 months instrument manuals

RELATED PROJECTS/ACTIVITIES

Air taxi training materials

Methodology to certify judgement

Cockpit Resource management manual/program

Basic Research for licensing and certification

R&D PERFORMANCE

Joint Research Project Arrangement with FAA

PROGRAM DESCRIPTION SHEET NO. 7

(November 1985)

PROJECT: Air Taxi Training Materials (3rd/4th level air carriers).

OPI: DLC/L

BACKGROUND

Air taxi, charter, and agriculture pilots have commercial incentives that affect their judgement. Current training materials do not contain information on judgement which reflects the differences between commercial and recreational pilots.

OBJECTIVE

Develop training material relative to air taxi (3rd/4th level air carrier) pilot judgement.

PROJECT DESCRIPTION

Training material will address those factors that affect commercial pilot judgement differently from recreational pilots i.e., commercial incentives.

PRODUCT

Training material on pilot judgement specifically oriented toward the air taxi pilot as well as other commercial pilots.

ESTIMATED COST

$20,000

TIME FRAME

Six months.

RELATED PROJECTS/ACTIVITIES

- Methodology to certify judgement;
- Cockpit resource management manual/program;
- Basic research for licensing and certification.

R&D PERFORMANCE

Joint Research Project Arrangement with FAA

PROJECT DESCRIPTION SHEET NO. 8

(November 1985)

PROJECT: Define Passenger Safety R&D Requirements Identified by DMSP Passenger Safety Study.

OPI: DSP/L

BACKGROUND

The Management Systems Group of Transport Canada is presently conducting a major **Review of the Aviation Regulation Organization with Respect to Passenger Safety** (T.C. Project No. 282-1080). While the study has not yet been released, a number of passenger safety problem areas have been identified, and corrective actions will be proposed. Some of these remedial actions may require R&D support, either in the form of new data or decision criteria or the development of new aeronautical products or procedures.

PROJECT OBJECTIVE

Determine/identify Passenger Safety R&D Requirements.

PROJECT DESCRIPTION

The major tasks involved in this project include:

- Evaluate Passenger Safety Study recommendations for corrective action;
- Determine benefits/costs of alternatives;
- Select preferred alternatives;
- Identify R&D requirements;

- Design/develop R&D projects.

PRODUCT

New R&D projects in the area of Passenger Safety.

ESTIMATED COST

$10,000.

TIME FRAME

Three months.

RELATED PROJECTS/ACTIVITIES

DMSP Passenger Safety Study implementation.

R&D PERFORMANCE

In-house

PROGRAM DESCRIPTION SHEET NO. 9

(November 1985)

PROJECT: Evaluation of "SAFE" Program Functional Classifications.

OPI: DSP/L

BACKGROUND

The System Analysis and Functional Evaluation Program ("SAFE" Program) System is based in part on the Canadian Forces Cause Factor System established for military operational purposes. In certain cases, the primary and sub-system components, particularly in the area of personnel, may not reflect the ideal mix of categories, e.g., to identify human factors research needs.

PROJECT OBJECTIVE

Determine SAFE program functional classification requirements.

PROJECT DESCRIPTION

The following projects tasks are involved:

- Review/evaluate system output requirements;
- Review/evaluate system inputs;
- Survey/review existing systems established for similar purposes in other countries (e.g., U.S. ASAS system);
- Review alternative classification systems in the light of identified needs;

- Select and implement.

PRODUCT

Functional classification of safety problem areas (system deficiencies).

ESTIMATED COST

$30,000.

TIME FRAME

Six months

RELATED PROJECTS/ACTIVITIES

Information needs for SAFE program.

R&D PERFORMANCE

Private contractor

PROJECT DESCRIPTION SHEET NO. 10

(November 1985)

PROJECT: Selection, Training and Certification Guidelines for Security Personnel.

OPI: DAX/L

BACKGROUND

The effectiveness of the Security Program depends to a significant degree on the competence, motivation and dedication of personnel selected to provide the services required. Currently, effectiveness is limited by tedium and other morale problems leading to inattentiveness and a high turnover of staff. The R&D Committee on Aviation Security has proposed measures to alleviate this problem through better selection methods (e.g., screening techniques, security clearances, etc.), design of training/motivation programs and finally, certification of candidates who have demonstrated a required standard of competence. R&D is required to demonstrate need and to assist in developing the necessary standards, methods and programs.

PROJECT OBJECTIVE

Provide information required to develop standards, training and motivation programs and certification requirements.

PROJECT DESCRIPTION

This project should be developed as a joint venture of the Aviation Group (KSP, FSC, DAX), the RCMP and the airlines who currently provide for security operations.

PRODUCT

Information required to develop cost-effective selection, training, motivation and certification.

ESTIMATED COST

$30,000

TIME FRAME

Six months.

R&D PERFORMANCE

Joint project with RCMP and airlines

PROGRAM DESCRIPTION SHEET NO. 11

(November 1985)

PROJECT: Methodology to Certify Judgement

OPI: DLC/L

BACKGROUND

In flight test guides there is a category called flight test judgement. However, there currently exists no quantifiable method by which flight instructors can assess pilot judgement.

Work in this area had been previously performed both in Canada and the U.S.

Some early work was performed in the area by a university in Ohio. Some of the methods proposed by this university were later tested by a second university in Florida.

In Canada, two experiments have been performed in this area with good results.

OBJECTIVE

Develop a method for certifying pilot judgement.

PROJECT DESCRIPTION

A quantitative method will be developed that will enable flight instructors to certify pilot judgement.

PRODUCT

The developed method will be a resource for providing flight instructors with a common basis for judgement certification.

ESTIMATED COST

$50,000

TIME FRAME

Nine months.

RELATED PROJECTS/ACTIVITIES

- Air taxi trainig materials;
- Cockpit resource management manual/program;
- Basic research for licensing and certification.

R&D PERFORMANCE

Joint Research Project Arrangement with FAA

PROJECT DESCRIPTION SHEET NO. 12

(November 1985)

PROJECT: Develop Supporting Audio Visual Training Materials for: Private Pilots, Instructors, Instrument/Commercial Pilots, Civil Aviation Inspectors and Examiners.

OPI: DLC/L

BACKGROUND

The private pilot and instructor manuals have been tested in various programs in the United States, Canada and France in order to assess their effectiveness. Results have been very favorable.

OBJECTIVE

To develop training aids for use during workshops.

PROJECT DESCRIPTION

These training materials will address those factors that effect private pilots, instructors and instrument rated pilots in their decision-making skills.

PRODUCT

Training materials oriented around the particular needs of these pilot groups.

ESTIMATED COST

$100,000.

TIME FRAME

6 months private pilot materials

9 months instructor materials

12 months instrument materials

12 months commercial materials

12 months inspector/examiner materials

RELATED PROJECTS/ACTIVITIES

Air taxi training materials

Methodology to certify judgement

Cockpit Resource management manual/program

Basic research for licensing and certification

R&D PERFORMANCE

Joint Research Project Arrangement with FAA

PROJECT DESCRIPTION SHEET NO. 13

(November 1985)

PROJECT: Passenger Protective Breathing Equipment.

OPI: DLC/L

BACKGROUND

Incapacitation due to inhalation of toxic gas and smoke has caused the majority of transport aircraft fire fatalities in the last decade.

One of the recommendations following the investigation into the DC-9 accident at Cincinnati was to expedite the research necessary to develop the technology, equipment standards and procedures required to provide passengers with respiratory protection from toxic atmospheres during in-flight emergencies aboard transport category aircraft. A possible solution to this problem is the provision of protective breathing equipment to each passenger.

In mid-1984 the Transportation Development Centre initiated a project to:

a) Produce a set of criteria for an appropriate passenger protective breathing device;

b) To determine whether any existing devices meet the defined criteria;

c) Recommend necessary research/development required.

OBJECTIVE

Should the current project establish that no existing device will meet the criteria further work will be required to develop and test a prototype device.

PROJECT DESCRIPTION

Design of this project will await results of TDC Smoke Mask Criteria Project, due to be released shortly.

PRODUCT

Protective breathing device to support possible future regulation on this issue.

ESTIMATED COST

$100,000.

TIME FRAME

One year.

R&D PERFORMANCE

Transportation Development Centre

PROJECT DESCRIPTION SHEET NO. 14

(November 1985)

PROJECT: Aircraft Overloading Study.

OPI: DEL/L

BACKGROUND

The overloading of aircraft, especially during the transport of passengers by commercial air services, is a matter of serious concern. Accidents involving overloading are often serious and result in fatalities. Thus, they tend to capture public attention and raise doubts about the effectiveness of CATA's enforcement programs to deal with overloading of aircraft. Consequently, CATA Senior Management has directed that specific strategies be developed to regulate and control the practice of aircraft overloading.

PROJECT OBJECTIVE

Determine the nature and extent of overloading and the adequacy and effectiveness of current regulatory controls, and programs. Recommend corrective action as required.

PROJECT DESCRIPTION

The following specific points will need to be addressed:

- Definition of Overloading;
- Identification of safety hazards associated with overloading;

- Relationship of overloading with a number of factors, including seasonality, geography, operating environment, pilot characteristics, etc;
- Determination of effective regulatory/enforcement counter-measures.

CURRENT STATUS

Terms of Reference have been drawn up. DEL has undertaken the study but has had to abandon the use of a proposed questionnaire on the basis that the information it elicited would likely be unreliable under any circumstances. Therefore, the study is limited to research of available information.

PRODUCT

Analysis and Recommendations for Corrective Action.

ESTIMATED COST

$25,000.

TIME FRAME

Three months.

R&D PERFORMANCE

Combination in-house/private contractor as required.

PROJECT DESCRIPTION SHEET NO. 15

(November 1985)

PROJECT Aircraft Inspection Study.

OPI: DAB/L

BACKGROUND

Different regions have historically adopted different practices with respect to physical inspection of aircraft. During the A Base Review Study for example, resource recommendations were calculated against an arbitrary standard of a 10% inspection of the fleet of non-transport aircraft per year. There is, however, no objective basis by which to evaluate a given inspection policy in terms of frequency, sample, etc. or indeed whether CATA should conduct physical aircraft inspections as a regulatory task separate from audits, etc. In view of the existence of a variety of regulatory opinions on this matter, an independent study is proposed to resolve this issue and to develop a more rational aircraft inspection policy.

OBJECTIVE

To obtain a scientific basis with which to anchor DAB physical aircraft inspection policy.

PROJECT DESCRIPTION

Study to be carried out by consultants specializing in aircraft maintenance. The consultants would study regional files on aircraft inspections to determine what results were obtained. They would then conduct a field survey of several selected areas of Canada to obtain data on the airworthiness of aircraft located in that area. Findings would be analyzed to provide a basis for making policy recommendations to CATA Senior Management.

PRODUCT

- Data on effectiveness of regional aircraft inspections;
- Guidelines for frequency of physical aircraft inspections;
- Data on condition of aircraft in selected geographical areas of Canada.

ESTIMATED COST

Approximately $124,000.

TIME FRAME

One year.

R&D PERFORMANCE

Private engineering consultant.

PROJECT DESCRIPTION SHEET NO. 16

(November 1985)

PROJECT: External Loads on Aircraft

OPI: DAB/L

BACKGROUND

DOT is regularly faced with requests from operators/owners for information/ approval to carry a variety of "temporary" external loads (marine crafts, equipment, light structures, etc.) mostly on light aeroplanes. The large variety of load configurations, lack of available information and complexity of approval process deters applications for approval and encourages "illegal" flights with untested/unsafe load configurations.

OBJECTIVE

To establish benchmark data on the effect of various typical load configurations on the flight characteristics of different light aeroplanes to allow reliable evaluation, and limited extrapolation, to simplify and streamline evaluation.

DESCRIPTION

External loads generally affect, often to an unsafe level, the flight characteristics of the aircraft. The extent of this effect depends on basic aircraft flight characteristics and load configuration; the only reliable approach at the present time is flight testing of expected specific configurations. Project would involve:

1. Detailed review of situation to assess extent of need and extent of "untested/unsafe" operations.

2. Research, review and assessment of available data on existing "approved" installations (manufacturers, operators, ...).

3. Engineering evaluation of potential impact of various load configurations on the flight characteristics of different light aeroplanes through data assessment, wind tunnel testing, flight testing and computer modeling.

PRODUCT

Information/data to simplify "operational" review and provide guidance in establishing "safety" of specific load/aircraft combinations; this would support the development of future regulations, standards and advisory material.

ESTIMATED COST

$50,000.

TIME FRAME

1/2 to 1 year.

R&D PERFORMANCE

Aircraft manufacturers and government laboratory.

PROJECT DESCRIPTION SHEET NO. 17

(November 1985)

PROJECT: Performance on sub-standard runway surfaces.

OPI: DAB/L

BACKGROUND

Performance from wet runways is based on the application of an arbitrary factor, but rational determination does not exist for safe take-off and landing distances using unpaved runways or for surfaces covered with snow, slush or ice. Correction factors for these adverse conditions could be established through research, and would lead to the safer operation of aircraft of all sizes.

OBJECTIVE OF WORK

To establish basic data on take-off and landing performance of wheeled aircraft of all sizes operating from a variety of sub-standard surfaces.

PROJECT DESCRIPTION

This matter is of concern to Transport Canada, National Defence, the National Aeronautical Establishment, Canadian air carriers and Canadian aircraft manufacturers. A detailed work description should include inputs from all these sectors and an R&D program launched.

PRODUCT

The end result would be the publication of appropriate factors by Transport Canada to permit safe operation from sub-standard surfaces.

This information could be offered to ICAO for world-wide dissemination.

ESTIMATED COST

$150,000

TIME FRAME

Up to three years.

R&D PERFORMANCE

Analytical-aircraft manufacturer.
Experimental-government laboratory.

PROJECT DESCRIPTION SHEET NO. 18

(November 1985)

PROJECT: "Bear Paws"

OPI: DAB/L

BACKGROUND

Bear paws are pads affixed to the rear of helicopter skids to improve stability on soft ground. Many light helicopters, particularly those involved in "bush" operations are equipped with them. Bear paws are typically Canadian and not commonly utilized in the U.S.

OBJECTIVE

To determine the specific "operational" role and design parameters pertinent to bear paws and to develop basic standards/criteria.

DESCRIPTION

Bear paws are generally not available as "off-the-shelf" items and must be designed, built and tested by the applicant. Specific standards do not exist for them. Project tasks would include:

- Engineering evaluation and assessment of "bear paw landing gear" characteristics/dynamics;
- Review and assessment of existing "designs";
- Establishment of basic design criteria.

PRODUCT

Data gathered/generated will form the basis of standards/advisory material.

ESTIMATED COST

$15,000.

TIME FRAME

1 to 2 years.

R&D PERFORMANCE

Aircraft manufacturer and government laboratory.

PROJECT DESCRIPTION SHEET NO. 19

(November 1985)

PROJECT: Cockpit Resource Management Manual/Program

OPI: DLC/L

BACKGROUND

At least four major organizations have developed program courses on Cockpit Resource Management (CRM) at various levels:

1) A program offered by a U.S. firm.

2) Another U.S. firm has developed a correspondence course.

3) A major U.S. airline has a three and a half day program for $12,050 (U.S.).

4) A Dutch airline has a week-long human factors program.

There is a need for a shorter less expensive course for the pilots of small airlines.

OBJECTIVE

Develop a cockpit resource management manual/program.

PROJECT DESCRIPTION

A cockpit resource management manual would be developed to support a one day program.

PRODUCT

Shorter, less expensive CRM program will benefit pilots of smaller airlines.

ESTIMATED COST

$100,000

TIME FRAME

Twelve months.

RELATED PROJECTS/ACTIVITIES

- Methodology to certify judgement;
- Air taxi training materials;
- Basic research for licensing and certification.

R&D PERFORMANCE

Joint research project arrangement with FAA.

PROGRAM DESCRIPTION SHEET NO. 20

(November 1985)

PROJECT: Identification, Development and Coordination of Information Needs for "SAFE" Program.

OPI: DSP/L

BACKGROUND

The NCATS will be monitored with the help of a new safety information system (System Analysis and Functional Evaluation System or "SAFE") established to identify safety needs (or "system deficiencies") from which to develop cost-effective counter-measures in the form of safety program initiatives, enforcement proposals, regulatory modifications, or other administrative action. It may be regarded as a modest counter part to the U.S. Aviation Safety Analysis System (ASAS) and could eventually become a key safety planning and resource allocation tool. Safety actions can thus be keyed to well-defined and acknowledged safety problem areas.

The program is currently dependent for its effectivenss on a heterogeneous collection of information assembled from a variety of data systems originally designed for other purposes (AIDS, CADORS, accident reports, etc.)

PROJECT OBJECTIVE

Identify, develop and coordinate data requirements/specifications, formats and systems for collecting, storing and organizing the SAFE Program data-base.

PROJECT DESCRIPTION

Work required to meet project requirements would include the following:

- Identify/evaluate current information users and needs (based on user requirements);
- Evaluate current and potential (planned) information sources (e.g., Occurrence Reporting System);
- Identify information gaps and requirements;
- Identify/develop new data sources and formats;
- Consolidate/reorganize safety-related data bases;
- Modify system as required (Develop required hardware/software packages);
- Implement.

PRODUCT

Safety-related data collection and coordination system.

ESTIMATED COST

$50,000.

TIME FRAME

Twelve months plus ongoing refinement by SPA.

RELATED PROJECTS/ACTIVITIES

Evaluation of SAFE Program Functional classifications.

R&D PERFORMANCE

Private consultant.

PROJECT DESCRIPTION SHEET NO. 21

(November 1985)

PROJECT: Low Level Aircraft Operations

OPI: DAB/L

BACKGROUND

There are many tasks in Canada such as Fire Bombing, Pipe & Power Line Survey, Navigation Facilities Inspection, Aerial Application, etc., which require the usage of aircraft at very low level. Such low level operation can have a severe fatigue effect on the aircraft structure and could possibly lead to structural failure. Measurement and evaluation of this effect is required to enable Airworthiness Regulations to be drafted to ensure safe usage of aircraft in these types of operation.

OBJECTIVE

To measure and evaluate the structural fatigue effect of the low level role (LLR) operation in its various roles, on the aircraft structure and to use this evaluation to develop airworthiness regulations for the usage of such aircraft. In addition maintain a data bank for all LLR operations.

PROJECT DESCRIPTION

Use aircraft operating in the LLR for the collection of fatigue data and evaluate and relate this data to that of normal roles, with regard to it's effect on the structure.

CURRENT STATUS

A certain amount of data has been collected and evaluated in conjunction with N.R.C. NRC resources are limited and we have agreed to $2,500 yearly financial support for the reduction of data. Transport Canada also owns three Datamyte fatigue recorders which are presently on aircraft in service.

Project has been carried out on a time and resources available basis. Also depends upon cooperation of customers.

ESTIMATED COST

To date, approximately $35,000. Continuing costs aproximately $5,000/year at present rate of progress.

TIME FRAME

Ongoing.

R&D PERFORMANCE

Aircraft manufcturer and government laboratory.

PROJECT DESCRIPTION SHEET NO. 22

(November 1985)

PROJECT: Carriage of Bulk Liquids and Cyrogenics

OPI: DAB/L

BACKGROUND

For many years the containers for both bulk liquids and cryogenics were considered as cargo containers and as such were not covered by the airworthiness regulations. Only those items which directly affect the aircraft were reviewed: vent lines through the fuselage, weight and balance considerations, including the sloshing of liquids, etc.

Carriage of bulk liquids and cryogenics is becoming more common in air carrier operation. This is especially true in the northern areas of the country. Regular requests are received from operators for the approval of the containers for these items.

With the advent of the Transport Canada Transportation of Dangerous Goods Directorate plus the increase in applications the need for acceptable guidelines for approval of aircraft tank installations was recognized. This would allow the carriage of hazardous liquids in quantities that exceed the IATA/ICAO agreements and the Dangerous Goods agreements.

OBJECTIVE

Develop guidelines for carriage of bulk liquids and cyrogenics to support regulation.

PROJECT DESCRIPTION

Airworthiness Branch and Dangerous Goods (TDGR) have developed Airworthiness Manual Advisory which is presently under review. Agreement must be reached on its contents and results circulated to industry for comment.

PRODUCT

Technical information in support of new Airworthiness advisory material.

ESTIMATED COST

$30,000

TIME FRAME

One year.

R&D PERFORMANCE

Government laboratory.

PROJECT DESCRIPTION SHEET NO. 23

(November 1985)

PROJECT Determination of Survival Equipment Needs

OPI: DSP/L

BACKGROUND

Current regulations (Sparsely Settled Areas Order, ANO, Series V, No. 12) regarding emergency survival equipment dates back over fifty years. A report prepared for the Dubin Commission of Enquiry recommended development of a survival policy, leading to realistic regulation covering all items required to maximize the chances of human survival. More recently, the 1985 Management Guidelines called for a review of current regulations in this regard (Issue 3.1.19).

OBJECTIVE OF WORK

Develop technical recommendations regarding survival equipment and protective clothing that should be carried aboard Canadian aircraft, both in Southern and Northern (Sparsely Settled) areas of Canada, for use as input to policy decision on regulation update.

PROJECT DESCRIPTION

The project would consist of the following task elements:

- Review SAR Special Reports submitted over past ten years to identify cases where survival equipment has been inadequate (by geographic location, class of aircraft, etc.);

- Consult aviation community input;
- Develop survival requirements in the light of modern SAR location techniques;
- Develop inventory of food, equipment, and protective clothing requirements;
- Propose cost-effective solution.

PRODUCT

Technical and Economic justification for recommendations leading to regulatory review.

ESTIMATED COST

Costs are estimated to be $10,000.

TIMING

Two to three months.

R&D PERFORMANCE

Private contractor.

PROJECT DESCRIPTION SHEET NO. 24

(November 1985)

PROJECT: Effects of Hazardous Substances on Aircraft Maintenance Engineers and Airworthiness Inspectors.

OPI: DAB/L

BACKGROUND

Licenced Aircraft Maintenance Engineers and Airworthiness Inspectors are faced with working on aircraft that have been used to transport hazardous products. Examples would include aircraft used for pesticide spray purposes, hydraulic fluids, fuels, cleaning material, etc.

OBJECTIVE

To determine what hazards may exist and how to handle the risks associated with such hazards.

PROJECT DESCRIPTION

Study would be designed and carried out by specialists in the chemicals found in use in aircraft operations and aircraft uses such as spray operations.

PRODUCT

- Information on hazards faced:
- Policies, Guidelines and advisory material designed to protect aviation personnel.

ESTIMATED COST

Based on detailed study design. Initial cost $5,000.

TIME FRAME

Based on detailed study design.

R&D PERFORMANCE

Coordinate through NACARD Committee.

PROJECT DESCRIPTION SHEET NO. 25

(November 1985)

PROJECT: Skiplane Performance

OPI: DAB/L

BACKGROUND

A significant number of light aeroplanes are equipped with skis for the winter months (almost half of the year in the north). The lack of data available to the pilot on take-off and landing performance, coupled with terrain limitations, creates a definite safety hazard.

OBJECTIVE

To establish basic data on the effect of various "types" of snow on the take-off and landing performance of light aeroplanes.

DESCRIPTION

The lack of reliable and comprehensive data on skiplane performance on various "types" of snow, coupled with liability considerations, limits the flight manual performance data to a strict minimum. Pilots/operators thus have minimum guidance and must rely on experience alone (often limited). Project tasks would include:

1. Detailed review and assessment of available "snow" data in relation to ski operation.
2. Engineering and flight test evaluation of representative skiplane performance on various "types" of snow.

3. Establishment of reliable "snow" type determination criteria.

PRODUCT

Information/data to allow reliable "prediction" of skiplane performance on various snow "types"; this would support the development of appropriate advisory material.

ESTIMATED COST

$50,000.

TIME FRAME

1 to 2 years.

R&D PERFORMANCE

Government laboratory.

PROJECT DESCRIPTION SHEET NO. 26

(November 1985)

PROJECT: Determination of Educational Requirements for Passenger Education Program.

OPI: DSP/L

BACKGROUND

Accident investigation has revealed that passengers often make wrong moves in the first seconds after a crash that jeopardize the lives of themselves and others. One approach to this problem involves educating passengers through presentations at the departure gate, onboard films combining safety with a promotional message or the use of passenger volunteers in safety demonstrations. The issue of passenger education was highlighted at a Cabin Safety Conference and Workshop at Arlington, Virginia last December.

In Canada, passenger education was the topic of a presentation to Senior Management of the Aviation Group by the Safety Promotion Section of DSP.

PROJECT OBJECTIVE

Develop guidelines and make recommendations with respect to Passenger Education Program.

PROJECT DESCRIPTION

An attitudinal survey is proposed to determine passenger concerns and sensitivities/awareness of safety problem areas. (e.g., "fear of flying", attitudes to smoking and drinking aboard the aircraft, carry on luggage, attention to crew briefings, etc.). Tasks include:

- Questionnaire design;
- Pilot test of questionnaire;
- Questionnaire review and modification (if required);
- Passenger survey;
- Code/collate/analyze results;
- Report findings.

PRODUCT

Date on passenger attitudes.

ESTIMATED COST

$20,000 (depending on cooperation of airlines).

TIME FRAME

Three months.

R&D PERFORMANCE

Private contractor and airlines.

PROJECT DESCRIPTION SHEET NO. 27

(November 1985)

PROJECT: Safety Behaviour Modification

OPI: DEL/L

BACKGROUND

Accident prevention depends to a considerable degree on knowing why certain behavior occurred (the "pilot error") and then identifying ways and means of modifying that behaviour. Personality factors have been identified by several studies (e.g., Institute of Aviation Medicine, RAE Farnborough) as being important factors that contribute to an accident occurrence. High-risk personality traits can include under or over-confidence, nervousness and "macho" behaviour. It is important to isolate techniques of safety awareness and enhancement which can contribute to modifying the attitudes, and thus also the behaviour of certain classes of general aviation aircraft operators.

PROJECT OBJECTIVE

Identify/develop safety enhancement techniques to modify pilot behaviour to risk-taking.

PROJECT DESCRIPTION

Project tasks include:

- Analysis of accidents to determine frequency and cause of personality-induced accident occurrences;
- Psychological classification of causal factors by aircraft user class;

- Review of literature on available techniques that may be used to enhance pilot awareness of problem and lead to modification of future behaviour patterns;
- Design program that may be used in the field by RASO's, etc.

PRODUCT

New safety awareness enhancement methods and procedures.

ESTIMATED COST

$25,000.

TIME FRAME

Three months.

R&D PERFORMANCE

Coordinate through NACARD Committee.

PROJECT DESCRIPTION SHEET NO. 28

(November 1985)

PROJECT: Computerized Airworthiness Information System (CAIS).

OPI: DAB/L

BACKGROUND

A computerized aircraft information system (AIS) was developed in the Western Region several years ago to provide ready access to airworthiness information on all aircraft in the region. The Minister's Advisory Committee recommended the implementation of the system nation-wide in partial compliance with Dubin Recommendation No. 127, concerning investigation of all airworthiness incidents and the obligation to ensure corrective action.

OBJECTIVE

To develop and implement a Computerized Airworthiness Information System (CAIS) nation-wide.

PROJECT DESCRIPTION

CAIS is intended to provide airworthiness information on each individual Canadian registered aircraft to be available at each regional and district office as well as headquarters.

The system will enable information on possible aircraft defects to be automatically directed to the affected owners. It will also aid Airworthiness Inspectors in their surveillance and flight authorization activities.

CURRENT STATUS

DMSD has done a User Requirements and Feasibility Study. Funds have been obtained. Activity is presently ongoing to develop the computer program and purchase hardware. Close consultation with regional offices is being maintained to ensure a result acceptable to all concerned.

ESTIMATED COSTS

Total cost is estimated at $664,000.

TIME FRAME

1 to 2 years.

R&D PERFORMANCE

In-house and private contractor.

PROJECT DESCRIPTION SHEET NO. 29

(November 1985)

PROJECT: Evaluation of Enforcement Surveillance Activities.

OPI: DEL/L

BACKGROUND

Regulatory compliance may be achieved in two ways; prevention (before an infraction has occurred) and enforcement (after an infraction has been committed). The effectiveness of the Compliance program is determined by the effectiveness of the "regulatory presence" in modifying pilot behaviour on the one hand, and by the Aviation Group's ability to detect those violations that do take place, and apply effective deterrent action to prevent their recurrence on the other. Detection is particularly important to prevent the 200 accidents per year (28% of the total) which are reportedly caused by regulatory violations, whether directly or as a contributing factor. Furthermore, of the approximately 1200 regulatory violations detected annually, it is not clear what proportion of total infractions this represents. Furthermore, enforcement efforts have been directed largely to six main areas of regulatory violation, reckless operation, low flying, improper operation near an aerodrome, lack of certification, false certification and overweight conditions. Research is necessary to determine whether additional regulatory presence is required and where it should be directed.

PROJECT OBJECTIVE

Develop objective guidelines and criteria by which to evaluate the effectiveness of surveillance (detection) activities.

PROJECT DESCRIPTION

This project is a follow-on to the recent DEL Accident Violation Study. (Report in draft form). DEL should develop suitable terms of reference.

A survey should be designed and administered to the various detection sources including the regional inspectors, RCMP, Air Traffic Services, Flight Service Stations and others.

PRODUCT

Management information to target and evaluate effectiveness of surveillance activity.

ESTIMATED COST

$30,000.

TIME FRAME

Three months.

R&D PERFORMANCE

Private contractor.

PROJECT DESCRIPTION SHEET NO. 30

(November 1985)

PROJECT: Basic Research to Support Licensing and Certification

OPI: DLC/L

BACKGROUND

Provide basic research support for other DLC R&D programs.

PROJECT DESCRIPTION

In order to support research programs on a long-term basis, basic research will be performed in the areas of:

- Risk Management;
- Stress Management;
- Rehabilitation.

PRODUCT

Provides information/knowledge to support long-term objectives of Licensing and Certification Branch (DLC).

ESTIMATED COST

$50,000/year

TIME FRAME

Continuing

RELATED PROJECTS/ACTIVITIES

- Methodology to certify judgement;
- Air taxi training materials;
- Cockpit resource management manual/program.

R&D PERFORMANCE

Joint research project arrangement with FAA.

PROJECT DESCRIPTION SHEET NO. 31

(November 1985)

PROJECT: Evaluation of Effectiveness of Sanctions in deterring and correcting Regulatory violations.

OPI: DEL/L

BACKGROUND

History has shown that full regulatory compliance cannot be achieved without threat of vigorous enforcement action. However, it is not clear what the deterrent and corrective effect of the various administrative and judicial sanctions are. Research is required to provide information to guide future policy and decision-making so that DEL employs the sanctions which are most likely to correct detected violations and deter potential ones.

PROJECT OBJECTIVE

Determine the deterrent and corrective effect of various sanctions.

a) No further action;
b) Letters of Compliance;
c) Oral Warnings;
d) Letters of Warnings;
e) Suspensions;
f) Civil Penalties;
g) Prosecutions.

PROJECT DESCRIPTION

To analyze the relationship between sanctions and compliance with the regulations, study would:

a) Correction

- Examine the violation history of offenders by 5-year analysis of enforcement records;
- Establish the number of first offenders who repeat after receiving:
  - caution/warning;
  - suspension;
  - prosecution, etc.
- Examine the circumstances of cases where an individual has violated the registrations after a first sanction;
- Analyze and evaluate effectiveness of sanctions in correcting recidivist tendencies.

b) Deterrence

- Examine what factors increase/decrease deterrent effect (e.g., publicity, etc.)

PRODUCT

Policy information and decision criteria.

ESTIMATED COST

$40,000.

TIME FRAME

Four months.

R&D PERFORMANCE

Private contractor.

PROJECT DESCRIPTION SHEET NO. 32

(November 1985)

PROJECT: Repeat Offender Profile.

OPI: DEL/L

BACKGROUND

Deterrent actions are designed to modify errant behaviour. However, little is known about the attitudes and motivation of habitual violators, making it difficult to establish programs to deal with this segment of the pilot population.

PROJECT OBJECTIVE

Develop psychological profiles of repeat offenders.

PROJECT DESCRIPTION

In-depth study of a sample of those identified as "habitual violators" would be performed.

- Define "habitual violator";
- Select sample for analysis;
- Develop psychological profiles to determine;
    - attitudes towards safety;
    - attitudes towards compliance;
    - motivation towards regulations, etc.
    - other common traits, attitudes, etc.

PRODUCT

Decision-criteria for policy formulation and sanction selection when dealing with habitual offenders.

ESTIMATED COST

$30,000.

TIME FRAME

Three months.

RELATED ACTIVITIES

Profile of Pilots Killed in Accidents.

R&D PERFORMANCE

Private contractor.

PROFILE DESCRIPTION SHEET NO. 33

(November 1985)

PROJECT Profile of Pilots involved in Accidents.

OPI: DEL/L

BACKGROUND

The entire thrust of the enforcement program is aimed at preventing aircraft accidents by promoting compliance with air safety regulations, yet very little is known about the psychological make up of pilots who are involved in accidents.

PROJECT OBJECTIVE

Develop psychological profile of pilots who are involved in aircraft accidents, to determine any similarities with repeat offender profiles.

PROJECT DESCRIPTION

From a list of accidents select those where the pilot had an extensive violation history, and others at random. Develop a psychological profile to supplement the information developed in the Profile of Repeat Offenders project. The study should look at pilots who were killed, injured and uninjured in accidents.

PRODUCT

Decision-criteria for program targetting, policy formulation and sanction selection.

ESTIMATED COST

$40,000.

TIME FRAME

Four months.

RELATED ACTIVITIES

Repeat Offender Profile Study.

R&D PERFORMANCE

Coordinate through NACARD Committee.

APPENDIX B

R&D PROJECT EVALUATION AND SELECTION

APPENDIX B

R&D PROJECT EVALUATION AND SELECTION

"The point of greatest influence in the planning of an R&D activity occurs at the time of project/program selection. Since the projects/programs selected define the direction which the research effort will take, and also the extent and balance it will have, the choice of projects/programs and setting of priorities is critical. For these reasons, the selection of projects/programs and their relative priorities must be carried out in a comprehensive and formal manner".* This appendix describes the decision process used to assist the planning team in assigning priorities to the R&D program proposed in this study.

Four general classes of methods were reviewed for this purpose, economic methods, based on capital budgeting techniques, decision theory methods which employ decision tree diagramming together with a suitable form of analysis, constrained optimization methods, based on linear and dynamic programming techniques, and scoring methods, which compute overall project scores from ratings assigned to each project according to a list of relevant decision criteria. (cf. bibliography attached). It was found that a scoring method using "subjective" inputs to the decision process was by far the simplest and most effective approach in the present context. It is based on the method developed by the U.S. Department of Energy for its Solar Thermal Research and Development Program. It reportedly produces results which are "on the average, 90 percent rank-order consistent with economic and constrained methods".**

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* Treasury Board of Canada. "The Management of Research and Development: Framework and Guidelines".

** Solar Energy Research Institute "Solar Thermal Multi-year Researach Plan". Second Draft. Appendix A. Solar Energy Research Institute, Golden, Colo., 1982. Reviewed by Frank Krawiec in Research Management, March/April 1984.

Taking the project list ("wish list") as a starting point, the following are the formal steps that must be taken:

- decide who should be involved in the decision process. (i.e., who the review panel should be);
- select appropriate decision criteria;
- weight the importance to be attributed to the various decision criteria;
- score the program elements (projects);
- rank the program elements (score x weight);
- review and adjust (if necessary).

Results are clearly heavily dependent on the subjective judgements of panel members and the criteria employed in the decision process. Since no management structure was available within DSP (the R&D group has not yet come into existence), the preliminary ranking was undertaken by the consultant, based on interviews and consultant perceptions of client needs. However, subsequent project evaluation, selection and ranking would be the responsibility of the R&D group or of a small management R&D committee set up for the purpose. Details are as follows:

1. Review Panel

An R&D management panel must be established to review R&D proposals, either in the form of an DGAR committee established for the purpose, or in the form of an internal DSP management mechanism. Decision criteria may be revised from time-to-time by this panel, depending on the objectives to be achieved by the R&D program. It is important that the panel have no vested interest in any of the projects being evaluated.

2. Decision Criteria

Decision criteria, which provide the formal structure for the decision process, focus management attention on key issues and objectives. It is therefore important to be comprehensive and to include all the key issues. In the present context, the following criteria were used:*

i) Program Relevance

R&D projects in support of regulatory and non-regulatory program activities must be relevant to the priorities and objectives established by management, or determined as a result of system deficiency analysis. For example, the 1984 Management Guidelines singled out passenger safety as a priority area, and the 1984 Planning Overview, in addition to passenger safety (Initiative No. 3), emphasized commercial and business aviation (Initiative No. 2), Rotorcraft Airworthiness (Initiative No. 4), checkpoint automation (Initiative No. 12) and Human Factors Research (R&D Activity No. 1) amongst other issues.

ii) Government Sponsorship

The need for government sponsorship and funding will depend on access to similar work performed elsewhere if available, and on potential opportunities for negotiating joint project agreements within the framework of the McCleish-Helms agreement with the FAA or of some other appropriate vehicle.

iii) Criticality

Criticality is the degree to which the R&D project is regarded as critical (i.e., no alternatives available) to the achievement of safety objectives or of other objectives of the particular program or activity which it supports.

iv) Urgency

Urgency is a measure of the need for research findings or products, taking into account the lead time for the project.

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* Study ("R&D") to improve, refine and enhance the effectiveness of decision criteria (e.g., by quantification) should be ongoing.

v) Benefits Potential

Benefits potential is an assessment of the safety improvements that might be realized by the project (directly or indirectly) relative to the resources (human and financial) needed to complete the work.

vi) Benefit Risk Assessment

Benefit risk assessment is an evaluation of the likelihood of success of the project in achieving the objectives set for it.

vii) Resource Burden

Resource burden is the measure of annual funding relative to the total R&D costs needed to complete the project (i.e., $/year).

viii) Technical Merit

Technical merit is a measure of the intrinsic value of the project, whether to improve skills or in terms of additional non-safety related spin-offs available as a result of successful completion of the project.

3. Weighting of Decision Criteria

The importance to be attributed to the various decision criteria should be expressed by means of weights given to each of the criteria, to a total of 1.000. A "neutral" score for a single criterion (out of eight) would be 0.125.

4. Scoring of Program Elements (Projects)

Projects are scored individually by the management panel on a scale of one (lowest) to 10 (best) for each of the decision criteria chosen.

5. Ranking of Program Elements (Projects)

The projects are ranked by comparing the weighted average scores (SUB_s) of each program element:

$$SUB_s = \sum_{i=1}^{8} DC_{i,s} W_i,$$

where SUB_s is the total weighted score for program element "S", DC_i is the score of the decision criterion "i" and W_i is the weighting for decision criterion "i". Low rated projects may be given additional scrutiny to assess whether modifications might be brought to lessen chances of rejection.

6. Results

Results of ranking by the consultant may be followed by reference to three exhibits. Exhibit B.1, overleaf shows the weighting given to the eight separate decision criteria selected for this purpose. Greatest emphasis was given to judgements regarding the alignment of projects to program objectives (relevance), scope for sponsorship in cooperation with others, and the potential benefits that might be anticipated. Exhibit B.2, overleaf documents the unweighted scores allocated to projects for each criterion. Weighted scores providing results in the form of a preliminary ranking of program elements are documented in Exhibit 3, overleaf.

It is important to emphasize that these results are preliminary only. They should be regarded as the starting point of an ongoing process of evaluation and reevaluation in the light of changing circumstances, subsequently undertaken within AAR/DSP by a mechanism established specifically for the purpose. This could take the form of a committee of branch chiefs, a single individual responsibility or some other combination of criteria development and program review.

EXHIBIT B.1

FINAL WEIGHTING OF DECISION CRITERIA

CRITERION	SCORE
1. Program Relevance	0.200
2. Government Sponsorship	0.185
3. Criticality	0.075
4. Urgency	0.075
5. Benefits Potential	0.175
6. Benefit Risk Assessment	0.115
7. Resource Burden	0.090
8. Technical Merit	0.085
TOTAL:	1.000

N.B. Neutral score is 0.125

EXHIBIT B.2

PROJECT SCORING SHEET
(Highest Score = 10)

oject cription	1 Program Relevance	2 Government Sponsorship	3 Criticality	4 Urgency	5 Benefits Potential	6 Benefit Risk Assessment	7 Resource Burden	8 Technical Merit
ety Manage- t Planning	9.0	3.4	9.0	9.0	8.5	8.0	8.0	4.0
ormation for E	9.0	3.0	8.5	8.5	7.0	7.5	7.5	5.5
E Functional ssifications	9.0	4.5	8.5	8.5	7.0	7.5	7.5	5.0
senger Safety ds	9.0	7.5	7.5	7.5	7.0	6.0	6.0	4.5
s. Education uirements	7.5	7.5	6.0	6.0	6.0	5.5	5.5	4.5
aviour ification	7.5	7.5	6.0	5.5	5.5	5.0	5.5	5.5
Carriage icy	8.0	7.5	7.0	8.0	7.0	7.0	7.0	7.0
vival Needs	7.0	6.0	6.5	6.5	6.5	7.0	7.0	4.5
losives ur Detector	9.0	8.0	8.0	8.0	8.0	8.0	7.0	5.0
Screening	9.0	8.0	8.0	8.0	8.0	7.0	7.0	5.0

Project Descriptor	1 Program Relevance	2 Government Sponsorship	3 Criticality	4 Urgency	5 Benefits Potential	6 Benefit Risk Assessment	7 Resource Burden	8 Technical Merit
Passenger/Bag-gage Matching	9.0	6.5	7.5	7.5	7.5	7.0	7.0	5.0
Security Training	9.0	6.0	7.0	7.0	7.0	7.0	6.5	5.0
Surveillance Evaluation	7.0	6.0	6.5	6.5	7.0	4.5	6.0	4.0
Sanction Effectiveness	7.0	5.0	6.5	6.5	7.0	5.0	6.0	4.0
Repeat Offender Profile	6.5	5.0	6.5	6.5	5.0	5.0	6.0	4.0
Profile of Pilots Killed	6.0	5.0	6.0	6.0	5.0	5.0	6.0	4.0
Aircraft Over-loading Study	8.0	5.5	7.5	7.5	7.5	7.0	7.0	6.0
Aircraft Inspection	8.0	6.0	6.0	6.5	7.5	7.0	7.0	6.0
Performance on Substandard Runways	7.5	7.5	6.0	5.5	7.5	7.0	5.5	6.5
Hazardous Sub-stance Effects	7.5	6.0	6.0	6.0	7.0	7.0	6.5	3.5
External Loads Study	8.0	7.0	6.0	6.0	7.0	7.0	7.0	5.0
Bear Paws	8.0	7.0	6.0	6.0	7.0	7.0	7.0	5.0
CAIS System	7.0	5.0	6.0	6.0	7.0	7.0	4.0	7.0

Project Descriptor	1 Program Relevance	2 Government Sponsorship	3 Criticality	4 Urgency	5 Benefits Potential	6 Benefit Risk Assessment	7 Resource Burden	8 Technical Merit
kiplane erformance	7.5	5.0	6.0	6.0	7.0	7.0	6.5	5.0
pdate Pilot anuals	8.0	9.0	6.0	7.0	7.0	7.0	6.5	4.5
evelop Avia- ion Training anuals	8.0	9.0	4.0	6.5	7.0	7.0	6.5	4.0
ir Taxi Train- ng Materials	8.0	9.0	6.0	6.0	7.0	7.0	6.5	4.5
ethodology to ertify Judge- ent	8.0	9.0	6.0	4.0	7.0	7.0	6.5	4.5
ockpit Resource anagement	7.5	8.5	5.5	5.0	7.0	6.0	6.5	6.0
asic Research tudy	7.0	7.0	5.0	4.0	6.0	5.0	6.0	6.0
w Level perations	8.0	5.5	6.0	6.5	7.0	6.5	7.0	6.0
ss. Breathing quipment	8.0	7.0	6.5	6.5	7.5	7.0	5.5	6.0
lk Liquids/ rogenics	8.0	5.5	6.0	6.5	6.5	7.0	7.0	5.5

EXHIBIT B.3

FINAL RANKING OF RESEARCH PROGRAM ELEMENTS

PROJECT DESCRIPTION	WEIGHTED DECISION CRITERION								TOTAL
	1	2	3	4	5	6	7	8	
Explosive Vapour Detector	1.80	1.48	0.60	0.60	1.40	0.92	0.63	0.43	7.86
X-Ray Screening System	1.80	1.48	0.60	0.60	1.40	0.81	0.63	0.43	7.75
ELT Carriage Policy	1.60	1.39	0.53	0.60	1.23	0.81	0.63	0.60	7.39
Passenger Baggage Matching	1.80	1.20	0.56	0.56	1.31	0.81	0.63	0.43	7.30
Safety Management Planning	1.80	0.63	0.68	0.68	1.49	0.92	0.72	0.34	7.26
Update Pilot Manuals	1.60	1.67	0.45	0.53	1.23	0.81	0.59	0.38	7.26
Air Taxi Training Materials	1.60	1.68	0.45	0.45	1.23	0.81	0.59	0.38	7.19
Passenger Safety Needs	1.80	1.39	0.56	0.56	1.23	0.69	0.54	0.38	7.15
SAFE Functional Classifications	1.80	0.83	0.64	0.64	1.23	0.86	0.68	0.43	7.11
Security Training	1.80	1.12	0.53	0.53	1.23	0.81	0.59	0.43	7.04
Methodology to Certify Judgement	1.60	1.68	0.45	0.30	1.23	0.81	0.59	0.38	7.04
Develop Aviation Training Materials	1.60	1.67	0.30	0.49	1.23	0.81	0.59	0.34	7.03
Passenger Breathing Equipment	1.60	1.30	0.49	0.49	1.31	0.81	0.50	0.51	7.01
Aircraft Overloading	1.60	1.02	0.56	0.56	1.31	0.81	0.63	0.51	7.00
Aircraft Inspection	1.60	1.12	0.45	0.49	1.31	0.81	0.63	0.51	6.92
External Loads	1.60	1.30	0.45	0.45	1.23	0.81	0.63	0.43	6.92

PROJECT DESCRIPTION	WEIGHTED DECISION CRITERION								TOTAL
	1	2	3	4	5	6	7	8	
Performance on Substandard Runways	1.50	1.39	0.45	0.41	1.31	0.81	0.50	0.55	6.92
Bear Paws for Helicopters	1.60	1.30	0.45	0.45	1.23	0.81	0.63	0.43	6.90
Cockpit Resource Management	1.50	1.59	0.41	0.38	1.23	0.69	0.59	0.51	6.90
Information for SAFE	1.80	0.56	0.64	0.64	1.23	0.86	0.68	0.47	6.88
Low-level Operations	1.60	1.02	0.45	0.49	1.23	0.75	0.63	0.51	6.68
Bulk Liquids and Cyrogenics	1.60	1.02	0.45	0.49	1.14	0.81	0.63	0.47	6.61
Survival Needs	1.40	1.12	0.49	0.49	1.14	0.81	0.63	0.38	6.46
Hazardous Substances Effects	1.50	1.12	0.45	0.45	1.23	0.81	0.59	0.30	6.45
Skiplane Performance	1.50	0.93	0.45	0.45	1.23	0.81	0.59	0.43	6.39
Passenger Education Requirements	1.50	1.39	0.45	0.45	1.05	0.63	0.50	0.38	6.35
Pilot Behaviour Modification	1.50	1.39	0.45	0.41	0.96	0.58	0.50	0.47	6.26
CAIS System Implementation	1.40	0.93	0.45	0.45	1.23	0.81	0.36	0.60	6.23
Surveillance Evaluation	1.40	1.12	0.49	0.49	1.23	0.52	0.54	0.34	6.13
Basic Research Study	1.40	1.30	0.38	0.30	1.05	0.58	0.54	0.51	6.06
Sanctions Effectiveness	1.40	0.93	0.49	0.49	1.23	0.58	0.54	0.34	6.00
Repeat Offender Profile	1.30	0.93	0.49	0.49	0.88	0.58	0.54	0.34	5.55
Profile of Pilots Killed	1.20	0.93	0.45	0.45	0.88	0.58	0.54	0.34	5.37

APPENDIX C

DISCUSSION PAPER ON SAFETY OBJECTIVES

(Prepared for the National Air Transportation Safety Plan - NATSaP)

NATIONAL AIR TRANSPORTATION SAFETY PLAN

SAFETY OBJECTIVES

The Role Strategic Objectives of CATA include a requirement to ensure that an adequate level of safety is provided for the NCATS. What is adequate?

It is a product of society reaction to the safety record and the effective and efficient use of resources intended to improve the system. It is like freedom, or freedom of information, it is relative not absolute, and always capable of being improved.

The level of safety achieved for the air transport system is the culmination of the level of safety of its sub-parts and it cannot be better than the weakest sub-parts. In real terms, this means that the sub-parts of the vehicle, way, terminal need to be examined, but each should not necessarily cater equitably to the categories of air transport such as scheduled, non-scheduled, specialty operations, training, sport aviation, private aviation. Thus, an aircraft under 12,500 pounds used in training, sport, private, or non-scheduled operations possesses a different level of airworthiness than an aircraft over 12,500 pounds used in scheduled operations by virtue of the accepted international standards for such small and large aircraft.

While such differences could continue to be acceptable to the Canadian public, it is not so clear that unit-toll regular services which operate as third level carriers should be controlled by the "under 12,500 pounds" approach to safety. In fact, public reaction in Northern Ontario suggests otherwise and similar reactions across the country are appearing as the public becomes more familiar with air transportation.

Conceptually then, it is likely that fare paying unit-toll passengers on Classes I, II and III commercial services expect a consistent approach to safety, especially when it is possible for a passenger to commence a flight in a small community with a Class III carrier which enables him to transfer to a Class I or II carrier at a hub airport. Not only is safety a common aspect but so also is the desire to be provided a regular reliable service, even though the CTC II and III categories are not licenced with that obligation.

To achieve such a consistent approach it will be necessary to have equivalent standards for the vehicle, way, and terminal. It is not so today. The vehicle is designed to FAR 23 for small aircraft and FAR 25 for large aircraft, with different operating requirements under ANO VII for issue of an operating certificate. The way and terminal standards are even less rigidly specified and could be at the optimum level or lesser level for both large and small aircraft, depending upon the density of the route.

This suggests that the current CTC approach to carrier licencing may well be in need of review to also emphasize the safety-economics instead of solely the present convenience and necessity, and economics. A change in aircraft size groupings should defer to the safety design based upon regularity and reliability.

Returning to the need for a consistent approach for the vehicle, brings about the identification of the existing differences in the two airworthiness codes. The large (FAR 25) aircraft is designed to be fail-safe whereas the small (FAR 23) aircraft is not.

A small twin is incapable of sustaining stable controlled flight if an engine fails at maximum take-off weight during take-off. The aircraft will roll out of control and several accidents are attributed to this deficiency. The systems have no duplication feature. The structure is not fail-safe or built to a known safe-life to be controlled by inspection. The list could be extended considerably.

The way and terminal may be discussed together since each utilizes communications, visual and electronic aids, and positive control or air advisory; the latter two being ATS or Air Radio. Each of these sub-elements has evolved its own independent approach to providing safe, reliable operation, but they are not equally safe and reliable unless full compliance by the flight crews, air traffic controllers, and air radio operators is rigidly achieved to preclude conflicts. It would be more effective to develop conflict-free procedures in each sub-element and between elements.

So, as in the case of the vehicle where a need exists for fail-safe design, so in the way and terminal there is also a need for fail-safe features, irrespective of the type of services being provided, and these should require procedural solutions which automatically provide the safety features even if a procedural slip occurs. Alternatively, the procedural solution should render conflicts extremely improbable.

Returning to the consideration of non-scheduled services and specialty services, etc., a conceptual approach to be built upon the acceptability of less convenience makes sense, hence not the same demand to operate in all conditions. The success then will continue to depend upon the professionalism of the operators, pilots, etc., but a different emphasis could well exist for regulation and enforcement.

The temptation exists to attempt to develop probability objectives for all sub-parts, sub-categories and sub-elements of the system for the reliable regular passenger services. This has been utilized for the oceanic tracks on the North Atlantic and it is similarly used for many design features on the large aircraft.

Generally speaking the result is a failure objective classed as extremely remote and is expressed as "one in ten million". However, it should not result in a catastrophe thus it should be fail operational and result at worst in a system abort.

Less demanding objectives are tolerable such as "remote failure" or "one in a million". This is considered to be "fail passive" and continued safe flight is possible.

Also, "recurrent failures are fail passive" and readily handled or tolerated by operating procedures and the mission probably is completable.

However, the "extremely improbable" failure which has an unlikelihood of less than "one in ten million", i.e., 10 -7 would be considered as "fail catastrophic" and the results would produce fatalities.

Next, it is essential to consider combinations of failure such as two remote failures or 10 -6 X 10 -6 which is 10 -12 or "extremely improbable" and catastrophic. Thus in a vehicle, way or terminal only single failures should be tolerated. However, the cross-coupling between the vehicle, way, or terminal is worth examination as is the cross-coupling between sub-systems in each of the vehicle, way, and terminal.

Thus, a systematic failure analysis in the design and development of the vehicle, way, and terminal is essential to ensure that the desired safety objectives are achieved.

It is now possible to frame safety objectives as follows:

i) Unit toll passenger services should be planned to achieve a similar probability of failure irrespective of the regularity obligation.

ii) The level applicable in (i) is that of the design of vehicles over 12,500 pounds and as described in this document for remote, extremely remote, etc.

iii) Single failure should be the requirement in each of the vehicle, way, and terminal systems.

iv) Operating procedures should not have probabilities of failure that conflict with the system designs, nor of themselves have a probability of failure greater than the systems.

v) Compliance criteria for the foregoing should be unambiguous.

Source: CATA - The National Air Transportation Safety Plan (NATSAP): an Overview. Telecommunications and Electronics Branch (DTA), January 1980.

APPENDIX D

PERSONS INTERVIEWED

APPENDIX D

PERSONS INTERVIEWED
(in alphabetical order)

Mr. R.A. Anderchuk	Chief, Strategic Planning, Policy and Strategic Plannng, Aviation Group
Mr. G.S. Aitken	Chief, Systems Engineering Management, Air Navigation Services, Aviation Group
Mr. R. Beebe	Chief, Airworthiness Inspection, Airworthiness Branch, Aviation Group
Dr. S.V. Blizzard	Safety Support, Civil Aviation Medicine, Health and Welfare Canada
Mr. B. Bowie	Acting Director, Airport Services and Security, Aviation Group
Dr. G. Buch	Supervisor, Training Systems Evaluation, Licensing and Certification Branch, Aviation Group
Mr. S.R. Didrikson	Chief, Continuing Airworthiness, Airworthiness Branch, Aviation Group
Dr. R. Dodge	Deputy Director, Civil Aviation Medicine
Mr. D.J. Douglas	Director, Licensing and Certification, Aviation Regulation, Aviation Group
Mr. J.H. Enders	President, Flight Safety Foundation, Inc. Arlington, Va. U.S.A.
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Ms. S. Frogley	Aviation Safety Research and Analysis, Aviation Safety Programs Branch, Aviation Group
Mr. T. Hayman	Aerospace Directorate, Department of Regional Industrial Expansion

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Mr. R.T. Lewis	Chief, Planning, Research and Development Directorate, Transport Canada
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Mr. G.F. Marsters	Director, Airworthiness Branch, Aviation Group, Transport Canada
Mr. L.A. McCoomb	Director, Statistics and Forecasts, Policy and Strategic Planning, Aviation Group, Transport Canada
Mr. W.J. McCullough	Chief, Management Systems, Transport Canada
Mr. W. McLaughlin	Chief, Aviation Safety Promotion, Aviation Safety Programs Branch, Aviation Group, Transport Canada
Mr. D. McNeill	Chief, Quality Assurance, Facility Engineering and Systems Development, Air Navigation Directorate, Aviation Group, Transport Canada
Mr. J. Mew	Senior Policy Advisor, Airworthiness Branch, Aviation Group, Transport Canada
Mr. E.F. Morgan	Senior Consultant, Management Systems, Transport Canada
Mr. F.M. Murphy	Chief, Aviation Enforcement, Enforcement and Legislation Branch, Aviation Group, Transport Canada
Mr. W.R. Newton	Director, Enforcement and Legislation Branch, Aviation Group, Transport Canada

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Mr. S. Ray	Planing Air, Policy and Strategic Planning, Aviation Group, Transport Canada
Col. H.A. Rose	Director, Flight Safety, National Defense
Mr. G. Rosinski	Management Systems, Transport Canada
Mr. D.A. Schroeder	Program Manager, Aircraft Safety Program, Program Engineering and Maintenance Service, Federal Aviation Administration
Mr. P.B. Sheppard	Director, Civil Aviation Security, Aviation Regulation Directorate, Aviation Group, Transport Canada
Mr. R.W. Slaughter	Director, Aviation Safety Programs, Aviation Regulation Directorate, Aviation Group, Transport Canada
Mr. J.P. Stewart	Chief, Aviation Safety Research and Analysis, Aviation Safety Programs Branch, Aviation Group, Transport Canada
Dr. G.Y. Takahashi	Director, Civil Aviation Medicine
Mr. M. Tewfik	Transportation Development Centre
Mr. K.J. Thorneycroft	Inspector General, Transportation Safety, Transport Canada
Mr. M. Walker	Planning Advisor, Research Planning and Coordination, Research and Development Directorate, Transport Canada

APPENDIX E

SELECTED BIBLIOGRAPHY

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SELECTED BIBLIOGRAPHY

A. PLANNING DOCUMENTS - CANADA

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APPENDIX F

LIST OF DESIGNATORS

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As the present report was being completed it was announced that effective October 15, 1985 the Canadian Air Transportation Administration (CATA) would be reorganized into two distinct organizations, a Safety, Regulatory and ANS Group ("Aviation Group" for short) and an Airports Authority Group to streamline the management structure of major airports. The Aviation Group is comprised of two major Directorates, the ANS Directorate (formerly Air Navigation Branch) and the Regulatory Directorate (formerly Aviation Regulations Branch). The former Assistant Administrators (AAN and AAR) are currently entitled "Directors General" (DGAN and DGAR) and report to the Assistant Deputy Minister, Air (formerly the Administrator of the CATA).

The following are the designators used in the present report:

Organization	Designator
1. Directorates	
Flight Services	DGAF
Navigation Directorate	DGAN
Policy and Strategic Planning	DGAP
Regulatory Directorate	DGAR
Research and Development	DGRD
2. Regulatory Branch Organizations	
Airworthiness Branch	DAB
Aviation Security Branch	DAX
Enforcement and Legislation Branch	DEL
Licensing and Certification Branch	DLC
Aviation Safety Programs Branch	DSP

3. Airworthiness Branch Organizations

Airworthiness Standards	ABS
Airworthiness Programs	APB
Airworthiness Engineering	ABE
Flight Testing	ABF
Airworthiness Inspection	ABM
Continuing Airworthiness	ABC

4. Enforcement and Legislation Branch Organizations

Legislation and Regulations	ELL
Aviation Enforcement	ELE
Aeronautical Terminology	ELB
Aeronautics Act Task Force	ELR

5. Licensing and Certification Branch Organizations

Licensing	LCL
Air Carrier Certification and Inspection	LCO
Inspector/Engineer Training and Development	LIT

6. Aviation Safety Programs Branch Organizations

Safety Research and Analysis	SPA
Safety Promotion	SPP
Safety R&D (not yet established)	

7. Other Organizations

Canadian Aviation Safety Board	CASB
Transportation Development Centre	TDC
Aviation Medicine	DAM

Management Systems	DMSP
Department of National Defense	DND
Search and Rescue	SAR
National Research Council	NRC
Civil Aviation Medical Unit	CAMU